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THE RAILWAY OVER THE SAHÁRA FROM ALGERIA TO THE SENEGÁL, AND THE DESTRUCTION OF COLONEL FLATTERS.

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IT is openly asserted by French publicists that the only chance for France maintaining her position as a Great Power in Europe is to found colonies in Asia and Africa, and the cherished desire of the French nation is to have a great African Empire. To give birth to great colonies such as Australia and Canada they are confessedly unequal, as owing to well-known domestic habits their population is stagnant, and has no annual surplus thousands to throw off. To govern great subject empires such as India they are not qualified, for they have not as a nation sufficient self-restraint to be content with the affairs of empire and to leave the property in land of the subject races absolutely unviolated. What they mean by a colony is a country like Algeria, in which French citizens are encouraged to settle on lands from which the ancient proprietors have been ousted, not, however, cultivating them entirely themselves, but by the agency of the indigenous races reduced to serfage. Their object again is to make such colonies the strictly guarded commercial preserves of the mother country, the raw products of the subject country being collected mainly for the advantage of the conquering race. The manufactured products of the mother country are to be poured into the subject country, all competition with other European countries being barred by protective duties: the *raison d'être* of a colony is to constitute an exclusive mart for the home manufacturer.

Even in the mode of acquisition of their so-called colonies the French nation has a method of its own. Neither the Russian nor the English nation can plead innocence in the matter of annexation, but, when each case is examined, it will be found that there has been no deliberate design conceived beforehand of seeking an entirely new

country for purposes of conquest. The uncontrollable force of circumstances has driven both these nations forward on the path of empire against the wishes of the ruler, and even their repeated prohibition. The French nation, however, usually selects the spot which seems suitable to their operations; an explorer is sent forward, and makes a Treaty which founds rights; the Treaty is of course broken by the Native Power, and it is naively admitted that it is meant to be broken, and invasion and annexation follow, unless some obstacle arises or catastrophe intervenes. The exploration of the Sahára is a notable instance of a deliberate attempt to appropriate a vast region without the consent of the inhabitants, and without the shadow of a complaint against them as bad neighbours. Their country was wanted for the purpose of opening up a new market; their country was being annexed by a railway line.

France has two colonies in Africa north of the Equator. Algeria with Tunisia, which fronts to the Mediterranean, is bounded on the east by the Turkish province of Tripoli, on the west by the independent Kingdom of Morocco. The jealousy of Italy as regards Tripoli, and of Spain as regards Morocco, prevents all hope of French extension on either flank without a rupture with a European Power. To the south Nature has apparently placed a boundary in the Great Desert, which extends from the Atlantic to the Nile. This desert is not entirely uninhabited, for one of the most ancient races in the world maintains in its midst a precarious nomad existence, known to their neighbours as the Tuwárik, and to themselves as the Imoshagh, or Amazirgh, or "Free." They are cognates of the settled inhabitants of Algeria, Tunisia, and Morocco, who are known under the general name of Berber. They have outlived all the conquerors of North Africa, Phenicians, Greeks, Romans, Vandals, Arabs, and Turks, maintaining their rude liberties, and perhaps are destined to outlive the French rule also.

This Great Desert extends over fourteen degrees of north latitude, from 32° to 18°, at which point it reaches the great bend of the River Niger, on the north bank of which is the town of Timbáktu, inhabited by a pure negro population. Fifteen degrees of west longitude, 1° to 16°, from Timbáktu, is the unimportant French Colony of St. Louis, on the River Senegál. The banks of the river are occupied by independent tribes, and the nearest potentate of importance is the Mahometan Sovereign who dwells at Segu, on the east bank of the Niger. No European Power has any interests or commerce within many hundred miles; the climate is deadly and the exports insignificant. Yet it is the openly expressed desire and intention of the French people to extend this petty colony up the basin of the River Senegál and one of its branches, to cross the watershed of the Rivers Senegál and Niger, and place gunboats on that river, by means of which they hope to dominate over all the tribes inhabiting that all but unknown region as far as Lake Tsad, and finally to connect these regions by a railroad, which is to find its way across the Sahára, in spite of the awful desert and the unconquerable Tuwárik, to the frontier of Algeria. The conception is magnificent. Time and

NORTH ATLANTIC OCEAN
Bay of Biscay
FRANCE
AUSTRIA
ITALY
Adriatic Sea
R. Danube
BLACK S.
TURKISH EMP.
Meridian of Greenwich
C. Finisterre
Marseilles
Corsica
ROME
Naples
Brindisi
Trieste
Genoa
Oporto
Barcelona
MADRID
Valencia
Balearic Isles
Sardinia
LISBON
SPAIN
PORTUGAL
Carthagena
Malaga
Azores
C. St. Vincent
Cadiz
Gibraltar
Oran
Strait of Gibraltar
ALGIERS
Bona
Constantine
TUNIS
Sicily
GREECE
Candia
Cyprus
Nicosia
Malta
Madeira Isles
ALGERIA
TUNISIA
Sfakes
Gabes & Gulf
Jerba
TRIPOLI
Mesurata
Benghazi
Gulf of Sidra
Barca
Derna
Ras Sem
Tobruk
Alexandria
CAIRO
Canary Islands
C. Nun
C. Juby
C. Bojador
W. Draa
Tafilet
Figuig
Tuat
Tidikelt
Ghadames
El Hammada
Augila
Siwah
Bahrieh
Farafrah
Dakhel
Kharyeh
Siut
Asgar
FEZZAN
MURZUK
Zuela
Gatron
Gebabo
Kufarah
Libyan Desert
Nile R.
SAHARA OR GREAT DESERT
El Juf
Taodeni
Mabruk
Bardai
Wanyanga
Tibesti
Bilma
Kussi
Bodele
Air or Asben
Agades
Asiu
Shado
Tarso
Kelowi R.
Awellimiden
Asawad
Tegaza
Akela
Walata
Araouan
Tejuja
Tishit
TIMBUCTU
Gho or Gogo
Bubaru
Yaburi
Yaouri
Nyffe
Nupe
Kano
Nigimi
Mao
Damerghu
Lake Tsad
Bornu
Kuka
Kanem
Lagone
Wadai
ABESHR
DARFUR
KORDOFAN
Fasher
Obeidh
Dara
Takala
Shekka
Shoa
Bagirmi
Baghena
Kasumbara
Yowarri
Tenja
Labbezanga
Sansanding
Jenne
Sego
Bamaku
Bure
Bissagos I.
Wogodogho
Kulfela
Mandingoes
Kong
Bouna
Bussa
Yauri
Kebbi
Sokoto
Gando
Kano
Katsena
Zaria
Nyffe
Abuja
Kororofa
Homburi
Yola
Adamawa
Timbuctoo
Ngaundere
Kuti
Ajo
Dar Fertit
Dar Sidemat
Moño
Yassuf
Dar Banda
Dar Nyamnyam
Sere
Bongo
Mittoo
Monbuttu
Akka
Albert Nyanza
Kuta
Bahr Kuta
Wele R.
Kama
Munza
Mangbattu
Lake Chad
Bahr el Ghazal
Bahr el Abiad
Bahr el Zeraf
Bahr el Jebel
Bahr el Salamat
Bahr el Homr
Bahr el Arab
Bahr el Gazal
Bahr el Rek

the sacrifice of a vast amount of treasure and lives will be required, and, whatever may be the motive, it will be a great gain to civilization to have connected by a permanent way the Sudán with the Mediterranean. The first attempt to carry out this design has met with a rude check in the total destruction of the exploring party by the attack of the Tuwárik, who felt that their liberties were at stake. The object of this paper is to describe the nature of this check, and it is necessary previously to describe briefly the physical features of

I. Algeria with Tunisia,
II. The Senegál Colony,
III. The Sahára,

and then to narrate the history and the tragical end of the expedition, which took place in the last days of January or the first of February, 1881. No attempt has been made by the French Government to avenge their death or prosecute their undertaking.

In October, 1882, accompanied by my wife, I visited the Province of Algeria with Tunisia, with the double object of observing the French mode of managing subject provinces, a duty with which I had been familiar in India, and to study on the spot this great problem of the Trans-Sahára railway. The story of the massacre was very fresh then in men's minds, and it was constantly alluded to in the public press. The idea of this railway had something of fascination even for an outsider. It was a delightful exercise of fancy to draw straight lines across several degrees of latitude without coming within a hundred miles of a single village or well of water the whole way. A service of balloons seemed more suitable for the conditions of the country.

I traversed the Province of Algeria with Tunisia from Oran, on the frontier of Morocco, to Tunis, the capital of the newly annexed Tunisia. The old Bey, who had become a mere puppet, died while I was there, but the French Consul promptly placed a new puppet into the vacant chair, who did quite as well as the deceased dummy, and there was no perceptible change. The French system of administration is strong and judicious. A civil Government has succeeded to the former military despotism. Although I looked with the eye of a critic into the details of management, I could find nothing to complain of. There was peace and order in the towns, and entire safety to person and property in the open country. Excellent roads and railroads extended over the whole province. In the Bazaar, which it was a pleasure to visit, commerce was active. Not a soldier was to be seen except in their proper cantonments or fortifications. There were schools and courts of justice, with too much of the French language and too little of the Native vernacular to please me, but it is the characteristic of the French nation to believe that culture and progress can only be expressed in French, and in a conquered country the rulers need not learn the language, as the people must be made to learn French. This is just the contrary of our system in India, where the vernacular is made the instrument of civilization and order.

The province consists of one long narrow strip of country, down which a trunk railway runs from Oran to Tunis (not entirely completed); from this branches run to the ports of the Mediterranean, and branches cross the Atlas ranges to the south. The longest branch is that which connects Constantine with Batna, an important fortified town in an elevated situation in the Aures Mountains. I was present when this line was opened in person by the Governor-General, and had an opportunity of witnessing the ceremony and hearing the speeches. They were highly characteristic of the nation. From Batna a diligence drawn by eight horses, four abreast, conveyed us in sixteen hours through the pass of Kantára, down into the Sahára, and to the Oasis of Biskra. I passed the engineers on the road, lining out the extension of the railway, which will no doubt soon be carried out. For all practical purposes Biskra may be deemed the northern terminus of the Trans-Sahára railway, as Timbáktu is the southern terminus.

From the Oasis of Biskra I drove across the desert to the small but beautiful Oasis of Sidi Okba, where the great Arab conqueror of North Africa is buried. Very few holiday travellers ever see more of the Sahára than can be seen in this trip. Forty years hence perhaps a visit to Algeria will be incomplete without a run across the Sahára to Timbáktu. However, a great deal of the novel and strange beauty of the desert can be realized by a trip to Sidi Okba. It is a wonderful sight to drive out, as it were, into a sea of sand, while the lofty mountains of the Aures Range seem to sink into the horizon, and at length nothing but a few palms here and there mark an oasis. The Oasis of Sidi Okba comes into sight as a green island, with clusters of palms and minarets. After visiting the tomb of the great conqueror the traveller is taken up to the circular gallery of the minaret, where the muezzin was calling to prayers when I ascended, and a view of the vast desert extending to Timbáktu can be enjoyed. It is worth while making the excursion to the Sahára to see the palms, and taste their fruit while it is fresh, hanging in luscious branches from the stem, quite a different article from the dried article of commerce. There are 100,000 palms in the Oasis of Biskra alone: this tree delights to have its feet in water and its head in the fire of the sun.

The Algerian Sahára consists of just so much of the region south of the Atlas and Aures Ranges as the French have found it convenient or possible to annex: a chain of military frontier stations extends from the Morocco frontier, which will be gradually connected by railways to the High Plateau and Tell; they are Geryville, Laghouat, Golea, Ghardaia, and Wargla. From Biskra to Tuggurt is the Wadi Rhih, which has a dark-coloured settled population, is a distance of 139 miles, and from the military station is about the same distance to Wargla, the extreme frontier. These tracts are in the real Sahára, but there will be no difficulty in constructing a railway thus far, though it has not yet advanced to the stage of practical politics.

In this Algerian frontier we have a fair specimen of the much talked about *scientific* frontier which some years ago proved such a delightful snare to the British public. The science, if any, consists

in a great European Power laying its hand upon as much territory, belonging to a weaker State, as it happens to want, or is able to hold. England, France, Russia, Austria, and Germany have given most instructive instances of this wolf-and-lamb policy; the strangest feature is that the countries which like France are most sore at having a portion of their own territory lopped off by a stronger Power, are the most ready to violate the frontier of weaker States, having a strong feeling for their own independence, but none at all for that of their African and Asiatic neighbours.

Biskra is 410 feet above the level of the sea; after sunset I found it exceedingly cold in the month of October, and this is one of the features of the Sahára. Just below Biskra the traveller comes upon the chain of inland marsh lakes, which stretch across Tunisia to the Mediterranean. They represent the estuary or drainage of the vast river courses of the Great Sahára which are now dry and choked with sand. They are known as the Shotts of Tunis; the three largest are Melghir, below the level of the sea; Jerid, which is higher; and Rharsa, which is lower. In ancient times they are said to have been an arm of the Mediterranean, known as Lake Tritonis. One of the magnificent conceptions of the French is by a cutting to let the Mediterranean into this basin, with the object of improving the climate and rendering the Great Desert accessible to steamers. M. Roudaire, backed by M. Lesseps, has placed his scheme before the public, which has been met by serious objections, the initial one being the certainty of an enormous expenditure with a very doubtful profit. All French colonies cost the mother country very much more than they can ever return. The budget of Algeria presents a serious deficit, and no wonder when it appears that an army of 60,000 men is required to control a population of less than two millions in Algeria, and an additional 30,000 for Tunisia. British India would not pay its way if the army had such a proportion to the population. At Tunis I asked the distinguished Consul-General of the German Empire what was the nature of his instructions, as far as they could with propriety be divulged. His reply was very frank, that the French were to be encouraged to annex as large a portion of Africa as they could possibly desire. Prince Bismarck foresees the advantage of a large proportion of the French Army being detained on foreign duty.

Let us turn our attention now to the Senegál colony. The prominent position occupied by this previously unimportant colony is entirely due to the energy and determination of a most distinguished military officer, General Faidherbe, now Grand Master of the Legion of Honour, but for twelve years, from 1855 to 1864, Governor of Senegál. I had the honour of an interview with him at the Palace of the Legion of Honour at Paris in 1882, and he is distinguished as a scholar as well as an administrator. I found him entirely a cripple, and he attributed his malady to the pestiferous climate of his province. It occurred to me that I and scores of other public servants had been twenty-five to thirty years in India, and that we were generally stronger than our contemporaries who had never left England; in fact, it is another feature of French colonization, that they are in-

duced to choose unhealthy localities, such as the Senegál, the Gabún, and Tonquin. General Faidherbe presented me with a small pamphlet which he had just published with the interesting title of "Le Sudán-Français," giving an account of the experiences and aspirations of the colony. A great many other writers have published works much in the same strain. It is worthy of remark that the General thinks poorly of the Trans-Sahára Railway scheme, and would prefer to have the commerce of the interior brought by his railway from the Niger to the Senegál. He also in words repudiates the use of brutal force, as condemned by public opinion, and yet every step of the advance made by himself and his successors is based upon cannon, soldiers, and gunboats. It is not the quiet progress up-stream of the missionary or the merchant, but the deliberate advance of armed forces, storming towns, fighting battles, building forts, and annexing territory. And if this is not *force brutale*, it is difficult to translate the word. And the whole policy emanates from the Republican Ministry at Paris, and not from the insubordinate high-handedness of the local Governor.

Up to 1854 the French had only a few commercial establishments on the Senegál, St. Louis on the Atlantic coast, and Bakel and Senudébo were the furthest points in the interior on the Rivers Senegál and Faleme; on the north of the river the wild Berber tribes, known as Zénaga, had much their own way; to the south were several kingdoms, some Mahometan and others Pagan Negro. The island of Goree had also been occupied just south of Cape Vert. The position of the French traders was weak and humiliating, something like that of the English in Bengal before the battle of Plassy. Like Clive, Faidherbe changed the position of affairs; he thoroughly thrashed and subdued the Berber tribes on the north; he extended the protectorate of France over the petty States on the coast to the south. He fortified Bakel, and drove off the invading army of a great Mahometan Sovereign, who from his capital on the Niger gave out his intention of subduing all the Negro kingdoms, and driving the French into the sea. He extended the French influence further up the Senegál, and fortified the post of Medína, which had to undergo a long and dangerous siege from the Mahometans. Faidherbe in person relieved the garrison, and totally defeated the invading army, which never appeared again in the neighbourhood. During the years 1858, 1859, and 1860 Faidherbe extended the influence of the French over all the Negro kingdoms north of the River Gambia, occupied the harbour of Dakar, sent embassies to the Berber Chief of Adrar, and the Mahometan Toucouleur Chief of Segu on the Niger, offering terms of peace, and by the year 1865, when he left, this able and resolute soldier-governor had not only placed French interests on a solid foundation, but he had sketched out plans of magnificent annexation, which stood over for eleven years in the bureau of the Marine Department at Paris.

In 1876 they were carried out. Bafulábe was suddenly occupied on the Senegál, which here unites the two branches of the Ba-oule and Ba-Fing: along a branch of the former, the Ba-Khoy, lay the path of victory. Gallieni was sent forward on an embassy to Segu,

where he made a Treaty, but had his camp attacked and plundered: after him came Desbordes, who, in 1880, 1881, and 1882, defeated the tribes right and left, founding a chain of garrisoned posts at Badumbe, Kita, Kundu, Niaggasola, and finally Bammaku on the Niger. This place is distant from St. Louis on the Senegál 1,600 kilometres, or 1,000 miles, and from Khayes, a little south of Medína, where the navigation of the Senegál is interrupted, 520 kilometres, or 325 miles. Over this last distance the construction of a railway has been sanctioned (1879) by the French Republic, and is actually under construction, and in the last Report is a photograph of large viaducts already made. Another railway has actually been constructed from the commodious harbour of Dakar to St. Louis, the access to which is difficult on account of river-bar. Thence steamers ply to Khayes: thence the railway will in a very short period run to Bammaku. On the Niger will be placed war steamers, which will run up and down the great stream, and domineer over the tribes of this great river, up-stream as far as the Kingdom of Tembo, and down-stream as far as Timbáktu and beyond. But Timbáktu is the southern terminus of the great Trans-Sahára railway, and that is the object of the above diversion. The Treaty with Ahmadu, the Mahometan Sovereign of Segu, secures the French protectorate, and the exclusion of any other European State or merchant whatever. Protection in every sense is the beginning and end of every French Commercial Treaty, but the outlay is such that it may be doubtful whether the game is worth the expense of the candle. We have yet to learn whether there is any commerce worth developing in these countries, where the inhabitants are in such a low state of culture, and the line of railway through a population exceedingly hostile, not held in subjection, as in India, by a strong Government, but only domineered over by a chain of posts, appear to be liable to conditions of which we have no experience in any part of the world. Commerce may be and is carried on at its own risks and in its own peaceful way in foreign territory, in caravans or river steamers, in many parts of Asia and Africa, or it may be carried on in a country entirely subdued like Algeria, or British India; but the state of affairs from Medína on the Senegál to Timbáktu on the Niger differs widely from either of the above conditions.

Duponchel, one of the earliest and most enthusiastic advocates of the scheme, formulates it thus: solidly established in fortified posts on the Niger, connected by rail with Algeria and the Senegál, is a climate relatively healthy, domineering over the Upper and Lower Niger from its source to the mouth, the French will be masters of the Sudán. The object is to get the exclusive monopoly of the products of Central Africa, by being the first to get at it. The writer dreamt of a vast Empire of one hundred millions. He laughed at the idea of other European nations attempting to do the same, as if it were robbing France of its prerogative to have a preponderating influence in Central Africa, as it was not only her right, but her duty to claim the exclusive privilege of civilizing the people, and the benevolent work of establishing an African India, to which France had a

much better right than England ever had, or could possibly have, to the East Indies.

I have thus described the two colonies of France, Algeria with Tunisia on the north, and the French Sudán and Senegambia on the south. Between them lies the Great Sahára. A few words on the political and physical features of that mighty region. On the east the posts of Ghadámes and Ghát are within the Pashalik of Tripoli, and are part of the Turkish Empire. An English Consul has from time to time resided at Ghadámes; a Turkish garrison has from time to time occupied Ghát. On the west Figuig, Gurára, Angeroudh, Tidikelt, and Ain-Salah, in the Túat Oasis, belong to Morocco. The more advanced class of French pamphleteers suggest as a step precedent, that the Empire of Morocco should be divided between Spain and France, or taken entirely by France, or at any rate Morocco should be asked to give up all the places above mentioned. Such an idea perhaps scarcely enters into serious politics, as the annexation of Morocco would mean war with England as well as Spain, yet still, when once a tiger tastes blood, he never can have enough. No doubt the long necklace of oases, 160 miles long, with 400,000 inhabitants, known as the Túat, are exceedingly tempting, and Ain-Salah and Ghát are the keys of the position. Ain-Salah is equidistant from Algiers, Timbáktu, Mogadore, and Tripoli. Yet France dares not violate either frontier. She must work a central line from Wargla to some point equidistant from Timbáktu, and Agades in the Oasis of Air, which is in constant commercial intercourse through Ghát with Tripoli, as indeed Timbáktu is with Sus in the Empire of Morocco. There indeed the shoe pinches. There used in former days to be a direct caravan route from the Niger to Algeria, but it consisted entirely of slaves, who carried themselves and the light articles of export, such as ostrich feathers and gold dust; but with the abolition of the slave trade and slavery, the intercourse with Algeria ceased, while it still continues in full force with the less scrupulous (in this particular) people of Morocco and Tripoli.

But right in the passage of the French to the Sudán, between the Morocco and Tripoli frontier, dwell the indomitable tribes known as Tuwárik or Amazirgh, citizens of a Republic freer than that of France. These children of the desert are divided into two classes, the nobles and the serfs; the latter are black in colour, probably the aborigines of the country, before the Berbers, under pressure of Arab invasion, retreated from the coast to the desert. The nobles are divided into four great hordes: 1, the Ahaggar; 2, the Azjar; 3, the Kelowi; 4, the Awelimiden. Both nobles and serfs possess Negro slaves. The nobles are a remarkable race, preferring the desert and the tent to cities and fixed houses. They are monogamous, and allow their women full liberty in their action and choice of their husbands. The men wear veils, but the women have their faces exposed to view. Both sexes are tall, handsome, and intelligent, but as false as the Afghan, as addicted to rapine as the Turcoman, as quarrelsome among themselves in their tribes as the dogs of Constantinople. The inheritance of a man passes not to his son, but to

his sister's son, and a man's nobility is graded by the rank of his mother. These tribes never have known a master, and probably never will. They may be improved off the face of the earth, like the Red Indian, but they will not knuckle down as subjects. But there are other human factors to be dealt with in the Sahára besides the Tuwárik. Some are Berberized Arabs, like the Shamba, who reside near Wargla; some are Arabized Berbers. All are lax Mahometans, and still laxer in morals. Some formidable tribes are known as the "beni" or "aulád" of some particular person, like the sons of Diarmid, in the Scotch highlands. Such are the people.

Popular belief pictures the Sahára as an immense plain of moving sand, dotted here and there with fertile oases; it used to be deemed a flat ocean, devoid of all differences of level, vegetation, and water. Experience has taught us that it has a great variety of levels and characteristics, and it has its peculiar flora, and a certain, though limited, supply of water, which might be greatly increased by art, storage, and good government. There are lofty central mountains, as extensive as the range of the Alps. Barth, on his journey from Ghát to Agades, crossed a range at Egeri, by a pass of an altitude of 4,000 feet; the mountains are entered on the map as 5,000 feet; these are the Azjar highlands. The highlands of Ahaggar are still loftier; there is snow in these central ranges, and in all the narratives of travellers mention is made of the violent storms of rain, which carry all before them. Vast beds of rivers are traced through the whole region, and it is by them that the traveller finds his way, for they are entirely dry. The waters which flow southward from the southern slope of the Atlas, and northward from the central highlands, instead of flowing in these beds, sink into the sand, and take a subterranean course, known to the Tuwárik by covered reservoirs, to which he gets access, or by a well in some hollow, or they develop into an oasis. The French have largely introduced, and with great success, the use of artesian wells. The soil is good, if only water can be obtained. Palms spring up in hundreds round the newly discovered water, and under the shade of the palm other vegetation. The fatal desire of the Tuwárik to conceal these wells led to the destruction of many, and care has to be taken to keep new wells in repair, and prevent their being choked by the sand in motion.

The Wadi Igharghar and Wadi Mia are the two great roads by which access to the central watershed of the Sahára has been sought by the French, and never yet been effected. Guides are found with difficulty, but still they are found to show the way, and names have been assigned by tradition to numberless localities. The leading physical features are high rocky plateaux of hard gravel, which retain no mark of the camel's foot, vast dunes, the sand of the surface of which is raised by the winds. These dunes are grouped in lofty chains, extending in parallel lines north to south, and separated by stony defiles. Then there are isolated flat-topped cones, rounded off by the wearing away of the wind and rain; to all these features there is a distinct terminology; the horror of the scene can only faintly be

pourtrayed in the pictures with which the narratives of travellers are illustrated, and the intense fatigue and suffering, both of the man and the camel, cannot be described fully in words. The climate is indeed exceedingly healthy, but the heat intense; it is significantly recorded that no firewood or substitute for firewood being found, water and coffee were during the expedition boiled by powerful lenses attracting the rays of the sun to brass vessels, and in a few minutes boiling heat was attained. On the other hand the cold at night is intense, and such a sudden change of temperature must prove deleterious to health.

Commerce is put forward as the motive, but clearly conquest and glory are the chief attraction; there are no manufactured goods worth speaking of to be got from the Sudán, the raw produce consists of ivory, ostrich feathers, gold dust, ground nuts, and possibly cattle; on the other hand there are inexhaustible stores of salt in the desert, and no salt at all in the Sudán; the profit of the salt imported into the Sudán is fondly calculated upon as being likely to pay for the expense of the entire railway from Biskra to Timbáktu.

I now come to the last act, and the details of the tragedy. The Government of the French Republic were induced to make the experiment of a preparatory survey of the Sahára, and the greatest prudence was evinced in the selection of the means; it was to be a civil, not a military, enterprise, and was placed under the command of Colonel Flatters, an Officer of tried experience on the frontier at Laghouat, from which point he had well considered the question. I certainly gathered from the public press that he and his companions, though well versed in Arabic, were totally ignorant of the language of the Kabail, spoken by the Shamba, their guides, and the Tamáshek, spoken by the Tuwárik. This was a serious deficiency. They had with them one of the members of the religious fraternity of the Mahometan dervishes of the shrine of Temashin, near Tuggurt, which was believed to be a great assistance. Their guides were mainly of the tribe of Shamba, who were on friendly terms with the Azjar Tuwárik, but very hostile to the Ahaggar. Camels were purchased at a heavy price in large numbers. It was determined to follow the line of Wadi Igharghar, the Ghir of Ptolemy, the geographer, and leaving Ghát considerably on the east, to get to the south of the central highlands, whence there would be an open road to Timbáktu. The distance from Wargla to Timbáktu can be expressed either as 15 geographical degrees of latitude, or 1,800 kilometres, amounting to 1,100 miles.

The expedition left Wargla on March 5, 1880, and halting at many places, the chief of which were Feij Damran, Ain-Taibah, El Adhan, El Biodh, reached Temassinin on April 1, and Ain-al-Hajaj, April 6, where two Tuwárik emissaries came to the camp, and told them that the chiefs of the Azjar Tuwárik were at Ghát. This placed Colonel Flatters in the dilemma of either going to Ghát, to which he objected, or waiting for an unknown period the arrival of the chiefs. It is characteristic that, though on an expedition of a purely peaceful nature,

he regretted that he had not one hundred and fifty or two hundred of his soldiers to enable him to force his way. In his journal he tries to satisfy himself that such an organization would be quite as pacific, and much more independent, as the fear inspired would be more potent than the presents which he distributed. He gives us also his views of the political situation. In the check now offered to his progress he detected the influence of Turkey, which had lately occupied Ghát, under the pretence of putting a stop to the eternal quarrels of the Azjar and Ahaggar Tuwárik, and behind Turkey he detects the cloven foot of *perfide Albion*, always ready to thwart the legitimate expansion of France. Such reasoning would read as the expression of the narrow and jaundiced mind of an imperfectly informed soldier bitterly disappointed; but General Faidherbe, in 1881, after the destruction of Colonel Flatters, allows himself to indulge in expressions about the ingratitude of England in thwarting France in her scheme to civilize Africa. It appears incredible that England should have anything whatever to do with the failure of Colonel Flatters' first expedition across the Sahára, or even any knowledge of the project.

On the 16th April the expedition had moved to Lake Menkough, which proved to be their final stage. Colonel Flatters tried in vain to get an interview with Ikhonúden, the aged Chief of the Azjar, who kept himself out of the way, but sent some of his subordinates to spin out delays, while he, through the Turkish Governor of Ghát, applied to Tripoli for the orders of the Sultan of Turkey. The Colonel dared not advance into the territory of the Ahaggar Tuwárik without some previous communication; he was therefore obliged to give up his hope of working his way through the territory of the Azjar to the Lake of Amadghór, which was the object of his journey; there was nothing for it but to retrace his steps to Wargla, and put off the expedition for another year. Colonel Flatters went himself to Paris, to report the diplomatic complications which had supervened. Thus ended without success, and yet without loss of life or disgrace, the first expedition.

On the 4th December of the same year Colonel Flatters found himself on his return from Paris again at the head of his expedition, slightly modified in details, but prepared to attempt the passage across the Sahára by another and more westerly route. Before he started he received a message from the French Consul at Tripoli, full of anxious and sinister meaning, when read by the light of the coming catastrophe. The Governor of Ghát had written to Tripoli that Ahitaghen, the Chief of the Ahaggar Tuwárik, had received the letter which Colonel Flatters had written to him from Lake Menkough intimating his intention to pay him a visit, and had himself visited Ikhonúden, the Chief of the Azjar Tuwárik, and reproached him bitterly for having encouraged the mission to return; this reproach was quite unjustifiable, but it indicated the hostility of Ahitaghen.

The second expedition took the line of Wadi Mia. No European lived to return, so their progress can only be traced by their letters despatched on their route. They were heard of at Hassi Inafel on December 17, 1880, at Hassi Messaguem January 6, 1881, at Amguid

on Wadi Igharghar January 16, 1881, at Inzelman Tikhsin on January 29, 1881. Beyond this we know nothing for certain. The fate of the expedition could only be collected from the confused narrative of a few natives who straggled back to Wargla on the 2nd of April. In this progress, Colonel Flatters had indeed avoided the Turkish influences at Ghát, but he had got within the sphere of Morocco influence at Ain-Salah, in the Túat Oasis. He recommends, in one of his last letters, that a mission be sent to Ain-Salah, strong enough to defend itself, but not having a military appearance, *but the name of France speaking loudly behind it.* He was clearly quite prepared to bring pressure upon Morocco, though not on Turkey. He came across a caravan working its way with merchandize from the Sudán to Ghadámes and Tripoli. The exports from the Sudán were ostriches' feathers, gold dust, henna, dates, some cotton manufactures, carpets of the Sudán, and some black slaves. He found that the return caravan from Tripoli would bring European cotton manufactures, brass vessels, tea, and sugar. He came to the conclusion that slaves were the most valuable article of commerce, and as slavery was forbidden in Algeria, it might be expedient to substitute caravans of negroes under engagements for service, which would be in fact slavery in all but name.

It is noticeable that no member of the Ahaggar tribe had met the expedition. A messenger had been sent to Ahitaghen, but as he had not returned they halted five days at Amguid. Colonel Flatters felt that he was deflecting too much to the east, but he dared not venture across the great and waterless plateau which obstructed his course southwards. Their guide knew no route, and none of the Ahaggar tribe had hitherto volunteered to show one. At length the messenger returned with a letter from Ahitaghen, intimating that his brother-in-law, Shikkat ben Hanfu, would meet him at a halting place further on, and would be his guide. The Colonel believed the message, and his last letters were written in the highest spirits, as he fancied that his passage to the Sudán was secured. He moved on to Inselman Tikhsin on the 29th January, and wrote his last letters full of hope and confidence to his wife, his friends, and the French Government.

Nothing was heard further of the expedition, till on the 2nd of April forty native followers reached Wargla, in a miserable plight, with the sad news that all the Europeans had been killed and the camp plundered. Several conflicting accounts of the details are given. Colonel Flatters and some of the chief of his assistants were induced to leave the camp, and were killed, the Colonel falling by the hand of a Shamba, Saghir ben Shaikh, who had accompanied him on both his expeditions. Twenty-nine persons perished in this first onslaught. Lieutenant Dianous, who commanded in the camp, beat a retreat, but he was followed. Some Tuwárik, pretending friendship, supplied them with food, which was poisoned. They then attacked the retreating party, sixty-three in number, and killed nearly all. A few took refuge in a cave, and held it, sending four men to Wargla to beg for help. When help came, twelve alone found their way to Wargla: all the rest were starved.

On the other hand, the following letter, which is published as authentic, was sent by Ahitaghen to the Governor of Ghadámes: "You warned us to protect our land against the foreigner, and we have done so. Colonel Flatters came into our country, but the people have waged a holy war and massacred them all, and it is finished. Dear friend, let the news of these great actions be conveyed to Constantinople; let them know there what has happened, that the Tuwárik have waged a holy war against the Christians in an exemplary way, and that God has helped them to destroy them."

In another letter to a notable of Ghadámes, Ahitaghen writes: "For what reason do these Christians come to travel in our country? We never in all our lives saw them passing through our country. It is an impossible thing; they are not Christians under the protection of Mahometans; they belong to those Christians who wage a sacred war against the Mahometans, and do you pretend, in the letter that you have written to us, that they will cause us no injury? All is today finished. They have come, and they are dead."

We must not forget that the object of this mission, under whatever form disguised, was to place these regions under the French protectorate. The railway would only be the thin end of the wedge; it would lead to collision, facilitate invasion, and guarantee subjection. The Tuwárik are among the few nations who have never submitted to a foreign yoke. They resisted the Phenicians, the Romans, the Vandals, and the Arabs, and they instinctively felt that the crisis of their liberty was approaching.

No one seriously proposed to send a French military force to avenge these men, though they fell actually in the service of the State. Perhaps it was felt that they had no business there, and that it would have been better not to have sent them. It is shocking, however, to read in the Journal of the French Geographical Society, of April of this year, an exulting letter from the brother of one of the killed Officers, announcing that the head of Hamm al Shikkat, who murdered Captain Masson, had just then been brought into Wargla. A Shamba had deliberately gone on an expedition of assassination, and brought back this head, which may or may not be the head of the brother-in-law of Ahitaghen, who betrayed the party. At any rate it is scarcely credible that a Christian should have expressed in a public journal a hope that M. Tirman, the Governor-General of Algiers, who happens to be on a tour at Wargla, would encourage and stimulate the Shamba in their hereditary hatred of the Ahaggar to such enterprises as the one which cost the Hamm al Shikkat his life, in order to insure the due punishment of the Tuwárik, and to avenge, at least to some extent, the massacre of the Flatters Mission. Such an introduction of revenge and assassination is hardly a good type of Christian civilization, which it is the asserted mission of the French to extend to Africa, and it sets a dangerous example to a conquered people, as any Arab or Berber might kill any Frenchman taking him unawares. This is a mode of revenge and punishment which no one would tolerate in British India.

Looking into the future, I fear that the next century must see the

extinction of the unruly liberty of the Tuwárik in the same manner as the present century has seen the tribes of the Caucasus and the Turcoman pass under the yoke of a Great Power. It is the law of progress, but it should be done gradually, and by extending the arts of peace. The Tuwárik depend for their existence on the commodities which they can only purchase of the settled inhabitants in the different Oases of Ghadámes, Ghát, Ain-Salah, Agades, and others. The oases must be conquered first, and well governed, and from them a repressive control exerted over the nomads. When the great Pasha of Egypt, Mahomed Ali, had failed in his attempt to occupy Nejd, in the Arabian Desert, he assembled his Officers at Cairo, placed an apple in the centre of a carpet, and bade each try to get at the apple without placing his feet on the carpet. One after the other tried and failed. His adopted son, Ibrahim Pasha, who was short and stout, asked leave, in spite of derision, to try, and sitting down at the edge of the carpet, he began to roll it up from its rim inwards, until the apple was got at without difficulty. Mahomed Ali understood the enigma, and gave Ibrahim the command, who, by a gradual pushing forward of frontier fortresses and posts, at length captured the city. The French must adopt the same quiet policy, and they will find that the Sahára will be more profitably conquered by the boring rod of the artesian well than by the sword and chassepôt of the soldier.

List of Books.

Duveyrier: "Le Sahare."
Bulletin de Soc. Géographique de Paris: "Exploration du Sahare." 1882.
Largeau: "Le Sahare Algérie." Paris, 1881.
Brosselard: "Voyage de la Mission Flatters." Paris.
Bernard: "Quatre Mois dans le Sahare." Paris.
Gaffaret. "Explorations Françaises de 1870—1881." Paris, 1882.
Ancelle: "Français au Sénégal." Paris, 1883.
Bijemont: "La France en Afrique." Paris, 1883.
"Sénégal et Niger." Ministre de la Marine et des Colonies. Paris, 1884.
"Le Soudan Français." Général Faidherbe. Lille, 1881.
"Le Trace Central du Chemin de Fer Trans-Saharienne." Par Général Colonier. Paris, 1880.
"Le Chemin de Fer Trans-Saharienne." Duponchel. Paris, 1879.

The CHAIRMAN: I am sure we all feel much obliged to Mr. Cust for the interesting account he has just given us of the tour he made in the North African Colonies of France in the autumn of 1882, and we are especially indebted to him for the light which he has thrown, which I am afraid is all the light that ever will be thrown, on the sad fate of Colonel Flatters and his expedition in the preceding year. It struck me that Mr. Cust was a little severe in his criticism of the motives of the French Government in sending out that expedition. No doubt they were of a mixed character—they embraced the extension of political influence and the dis-

covery of new trade routes; but I almost doubt if Great Britain is the country to throw the first stone in a case of that kind, although of course during the last few years we all know that we have been on our good behaviour. But if France really indulges in the magnificent dream—not to call it chimera—of a Trans-Sahára Railway, I should be very much disposed to think with Prince Bismarck that it was all in the interests of civilization, and if she should, in doing so, interfere with the liberty and independence of the marauding Tuwárik, I really do not think after the picture that has been drawn by Mr. Cust of these interesting children of the desert, and their manners and customs, that we need waste a great deal of our sympathy upon them. However, that is neither here nor there. I believe myself, from what has fallen from Mr. Cust, that the destruction of Colonel Flatters and his party was due to the commencement of that great wave of Mohammedan fanaticism which has been sweeping over the continent of North Africa during the last few years, and to the force of which, no doubt, France may have contributed by the occupation of Tunis; although its origin must be due to causes of much longer duration and much more deep seated. It is by no means my intention, however, to keep you from the discussion of this very interesting paper, and therefore with these few prefatory remarks I will ask any gentlemen who are disposed to speak upon it to favour us with their observations.

Mr. E. Bunbury: I really have no remarks to offer except to express the very great interest with which I have listened to Mr. Cust's paper. I agree very much indeed with his views with regard to the probability of this railway, but really I have no more means of forming a judgment than any one else. My knowledge of the Sahára is precisely coextensive with Mr. Cust's, for I have only been as far as Sibi Okba, but even a journey of that very short distance gave us an impression of the desert which will never be forgotten. The view of the desert as one approaches it from the north can hardly be better characterized than was done by the French troops under Marshal Bugeaud, when they came to the brow of the hill. The portion of Algeria north of Biskra is a great undulating high land, and you come to the brow of a hill from which you suddenly see the desert stretching out in front. On arriving here the troops shouted at once, "La mer! La mer!"—they thought they had got to the sea again, and were delighted. I believe there has been a project mooted, and I believe M. Lesseps has given some currency to it, for rendering that in some degree a reality by creating a sort of island sea, where those salt lakes now exist. I confess myself that the whole thing appears to be an illusion, or at least that its effect will be infinitesimally small, and I perceive that in the last official investigation on the subject, they came to the same conclusion. If any one likes to try the experiment, and embark in it as a speculation, I shall be very willing to see them do so; but I should be very sorry to see any of my friends embarking their money in such a project.

Colonel Rhodes: The chief point in Mr. Cust's interesting lecture is Timbáktu—that is the central point you have to arrive at—and my object in rising is to bring forward Donald Mackenzie's scheme for "Flooding the Sahára." The point he selected was Cape Juby, 28° N. latitude, and he proposed to flood the Sahára down to Timbáktu. The depression of the Sahára goes round to within 50 miles of Timbáktu, and starts about 15 or 20 miles from Cape Juby. The distance across the desert is about 800 miles. The inhabitants on the south side of the Atlas range are pastoral, and the Morocco Government has very little control over them. They can hardly collect any taxes from them, on account of the high range of mountains which prevents the troops passing over on account of the extreme cold. The length of the depression, to which I have referred, is 500 miles, and its breadth 120 miles; it begins close to the French territory, and if the water were let into the Sahára, the French would have the benefit of the inland sea, instead of having to construct a railway. Diodorus Seculus records by tradition that this depression was suddenly dried up; in A.D. 681 it was an inland sea, but since A.D. 1200 the water has gradually disappeared. This vast plain, or depression, called "El Juf" (12 miles from the Atlantic Ocean), is a sterile region, but shells and pebbles are to be found all over it, the same as exist in the Atlantic Ocean. The salt mines, to which Mr. Cust referred, have been worked for about 500 years; they go a considerable depth into the soil, and the value of the salt when it is brought to Timbáktu is 1*l.*

per cwt. ; 20,000 camel loads of salt are extracted from those mines annually.[1] At the old entrance (Boca-Grandé) from the sea, at Cape Juby, there are perpendicular rocks rising 200 feet at each side, with a sand bar across, about 30 feet high at the sea end, and 10 feet high at the northern end, and it is that sand bar which keeps the Atlantic from coming into the depression of the Western Sahára. This perpendicular channel of high rocks extends inland towards the Sahára nearly 15 miles, and then opens into the "El Juf," its banks rise about 500 feet, and the bed of the channel varies to about 200 feet below the sea level. There is a port called St. Bartholomew, a little to the south of Cape Juby, at which Donald Mackenzie has established a trading station: that part is about 80 miles from the Canary Islands, and it is about 1,600 miles, or nine days' sail, from Cape Juby, to England. The ordinary caravan route from Algeria, Tunis, and Tripoli to Timbáktu is about 2,000 miles ; whereas the distance from Port Juby to Timbáktu is only 800 miles. The present trade of Timbáktu is about four millions sterling annually, and Donald Mackenzie thought that if the Sahára was inundated, instead of four millions it would be about twelve millions. At present goods leaving England have to go down to Sierra Leone, to the entrance of the Niger, then to go up the Niger, and altogether they have to pass through five hands before they are delivered at Timbáktu, thus five people have to receive a profit ; whereas, if they went from Cape Juby, they might go direct by steamers from Liverpool through the Canal right up to within 50 miles of Timbáktu, and land their goods there. A canal could also be constructed between the Niger (at Port Kabara) and this inland sea, so that there would be direct communication from Liverpool, with small steamers, without transhipment. If such a flooding of the Sahára were not to take place there, Mr. Mackenzie proposes to follow the Wadan trading route from Cape Juby to Timbáktu (about 800 miles), just skirting the western side of the depression of the Sahára. The Wadan route from Cape Juby to the interior has forty-two stations on the road, with abundance of water. I would therefore suggest that a railway should be constructed on this Wadan route to Timbáktu, by our mercantile princes of Manchester, so that they could deliver their goods at Timbáktu, the capital of the Western Soudan, which contains by estimation about thirty-eight millions of inhabitants, so that the trading facilities opened up by such a railway would be very great. I should therefore be glad to hear the question of constructing a railway from Port Juby to Timbáktu discussed at this meeting in conjunction with Donald Mackenzie's plan of "Flooding the Western Sahára Desert."

Colonel BAYLIS : I should like to ask whether the same occurrence might not again take place, namely, that if the water were let in, it might find an outlet as before. May not the same cause still exist which led to the drying of the desert, so that if the water were let in it might be absorbed again ?

Colonel RHODES : According to the traditions of the Arabs the water commenced to dry up in 681, and it took from 681 until the year 1200 for it to gradually disappear.

Colonel BAYLIS : By penetration ?

Colonel RHODES : I think by absorption. If such a scheme as this were carried out, it would change the climate of the Sahára and produce excellent vegetation, and we should also get our goods from Liverpool or Manchester delivered at Timbáktu without going up the Niger, a geographical distance of $12\frac{1}{2}°$ of inland navigation—or nearly 800 miles.

Major GRIMSTONE : I should like to ask the Colonel whether there is any population in this depression in the Sahára, because, if so, you would flood that population.

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Major GRIMSTONE: Mr. Cust has stated that there is one of these lakes that he refers to that is above the sea level. In his project of an inland lake in Tunisia, what arrangements would M. Lesseps make with regard to that lake?

Mr. CUST: He must answer for his own scheme; it is not my scheme. The sea would find its own level; I cannot understand it at all.

Captain JOHNSTONE, R.N.: With regard to the railway the French propose to make, I think I understood Mr. Cust to say the country is not completely desert. It would be interesting to know if, where this line of railway comes, there is any vegetation to speak of, if there are any wells, and how the railway would be kept up. Of course there would have to be stations, and then comes the point whether, if there is any population, the railway might not be destroyed. It seems to me to be a very important point to consider, when the railway has once been established, what possible means there will be of keeping it up. If there were any hostile tribes near, naturally the railway would not exist long when they once found out that by moving the rails it could be put an end to. Of course if there is no water in the place (as it is quite clear that the trains would not be able to carry water enough for themselves), they would not be able to run.

Mr. CUST: There again I am not the engineer, but I have read all the papers. The French draw very much upon the Bank of Hope; they think that they can sink artesian wells for the whole distance. There really is reason to believe that there is a current of water flowing from the highlands under the soil, and that they can get access at certain places to subterranean lakes of fresh water: I think there is no question that, wherever an artesian well is bored, the water flows up in a magnificent supply. The idea is to find a line along which there is a subterranean course of water, and to get their water there. Who is to protect the line between the stations they do not attempt to state, nor how passengers will be able to go through the intense heat of the day and the intense cold of the night, nor how they will get supplies of provisions: all these points have hardly come as yet into the question of practical engineering. Remember that the French Government has only sent out an expedition to survey; there is no contract made for the construction of the railway. A railway will no doubt be made as far as Wargla, and owing to the quantity of artesian wells that the French have sunk, causing palm trees to spring up by hundreds and thousands, there will be no difficulty about making that railway. But beyond it is entirely a vague and abstract scheme, which none but the most sanguine people would entertain for a moment. I should like to ask Mr. Bunbury if he can tell us anything about the expedition made by the ancient Romans across the desert in the time of Augustus.

Mr. BUNBURY: The Roman expedition in the time of Augustus went but a little way. They only penetrated as far as Fezzan, while Ghadames was the farthest point retained by them as a permanent outpost. There is in Ptolemy's geography an account of two expeditions that took place at a later period, in the time of the Antonines, just before his own time, carried out by two Generals who separately marched with an army from Tripoli to Fezzan and from thence to the south, until they came to a latitude which, according to Ptolemy's geography, brings them down far below the equator. There is no doubt that they did not make any such march as that. The geography of this march is entirely based upon the fact that because they occupied a certain number of months on the expedition altogether, by converting that into days' marches, assuming that they were always on the march and always marching the same distance, they would have got that enormous distance to the south. Although these marches must be looked upon as perfectly fabulous, still there is no doubt that they actually did penetrate far into the interior, but I should think they certainly did not go to Bornu, because if they had done so they would hardly have failed to mention the lakes.

Mr. CUST: Where do you place the River Ghir which Ptolemy mentions?

Mr. BUNBURY: Ptolemy's ideas of the geography of this part of Africa were perfectly confused. He got hold of names without knowing anything of their position, so that it is really idle to attempt to identify them.

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per cwt.; 20,000 camel loads of salt are extracted from those mines annually.[1] At the old entrance (Boca-Grandé) from the sea, at Cape Juby, there are perpendicular rocks rising 200 feet at each side, with a sand bar across, about 30 feet high at the sea end, and 10 feet high at the northern end, and it is that sand bar which keeps the Atlantic from coming into the depression of the Western Sahára. This perpendicular channel of high rocks extends inland towards the Sahára nearly 15 miles, and then opens into the "El Juf," its banks rise about 500 feet, and the bed of the channel varies to about 200 feet below the sea level. There is a port called St. Bartholomew, a little to the south of Cape Juby, at which Donald Mackenzie has established a trading station: that part is about 80 miles from the Canary Islands, and it is about 1,600 miles, or nine days' sail, from Cape Juby, to England. The ordinary caravan route from Algeria, Tunis, and Tripoli to Timbáktu is about 2,000 miles; whereas the distance from Port Juby to Timbáktu is only 800 miles. The present trade of Timbáktu is about four millions sterling annually, and Donald Mackenzie thought that if the Sahára was inundated, instead of four millions it would be about twelve millions. At present goods leaving England have to go down to Sierra Leone, to the entrance of the Niger, then to go up the Niger, and altogether they have to pass through five hands before they are delivered at Timbáktu, thus five people have to receive a profit; whereas, if they went from Cape Juby, they might go direct by steamers from Liverpool through the Canal right up to within 50 miles of Timbáktu, and land their goods there. A canal could also be constructed between the Niger (at Port Kabara) and this inland sea, so that there would be direct communication from Liverpool, with small steamers, without transhipment. If such a flooding of the Sahára were not to take place there, Mr. Mackenzie proposes to follow the Wadan trading route from Cape Juby to Timbáktu (about 800 miles), just skirting the western side of the depression of the Sahára. The Wadan route from Cape Juby to the interior has forty-two stations on the road, with abundance of water. I would therefore suggest that a railway should be constructed on this Wadan route to Timbáktu, by our mercantile princes of Manchester, so that they could deliver their goods at Timbáktu, the capital of the Western Soudan, which contains by estimation about thirty-eight millions of inhabitants, so that the trading facilities opened up by such a railway would be very great. I should therefore be glad to hear the question of constructing a railway from Port Juby to Timbáktu discussed at this meeting in conjunction with Donald Mackenzie's plan of "Flooding the Western Sahára Desert."

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Major GRIMSTONE: Mr. Cust has stated that there is one of these lakes that he refers to that is above the sea level. In his project of an inland lake in Tunisia, what arrangements would M. Lesseps make with regard to that lake?

Mr. CUST: He must answer for his own scheme; it is not my scheme. The sea would find its own level; I cannot understand it at all.

Captain JOHNSTONE, R.N.: With regard to the railway the French propose to make, I think I understood Mr. Cust to say the country is not completely desert. It would be interesting to know if, where this line of railway comes, there is any vegetation to speak of, if there are any wells, and how the railway would be kept up. Of course there would have to be stations, and then comes the point whether, if there is any population, the railway might not be destroyed. It seems to me to be a very important point to consider, when the railway has once been established, what possible means there will be of keeping it up. If there were any hostile tribes near, naturally the railway would not exist long when they once found out that by moving the rails it could be put an end to. Of course if there is no water in the place (as it is quite clear that the trains would not be able to carry water enough for themselves), they would not be able to run.

Mr. CUST: There again I am not the engineer, but I have read all the papers. The French draw very much upon the Bank of Hope; they think that they can sink artesian wells for the whole distance. There really is reason to believe that there is a current of water flowing from the highlands under the soil, and that they can get access at certain places to subterranean lakes of fresh water: I think there is no question that, wherever an artesian well is bored, the water flows up in a magnificent supply. The idea is to find a line along which there is a subterranean course of water, and to get their water there. Who is to protect the line between the stations they do not attempt to state, nor how passengers will be able to go through the intense heat of the day and the intense cold of the night, nor how they will get supplies of provisions: all these points have hardly come as yet into the question of practical engineering. Remember that the French Government has only sent out an expedition to survey; there is no contract made for the construction of the railway. A railway will no doubt be made as far as Wargla, and owing to the quantity of artesian wells that the French have sunk, causing palm trees to spring up by hundreds and thousands, there will be no difficulty about making that railway. But beyond it is entirely a vague and abstract scheme, which none but the most sanguine people would entertain for a moment. I should like to ask Mr. Bunbury if he can tell us anything about the expedition made by the ancient Romans across the desert in the time of Augustus.

Mr. BUNBURY: The Roman expedition in the time of Augustus went but a little way. They only penetrated as far as Fezzan, while Ghadames was the farthest point retained by them as a permanent outpost. There is in Ptolemy's geography an account of two expeditions that took place at a later period, in the time of the Antonines, just before his own time, carried out by two Generals who separately marched with an army from Tripoli to Fezzan and from thence to the south, until they came to a latitude which, according to Ptolemy's geography, brings them down far below the equator. There is no doubt that they did not make any such march as that. The geography of this march is entirely based upon the fact that because they occupied a certain number of months on the expedition altogether, by converting that into days' marches, assuming that they were always on the march and always marching the same distance, they would have got that enormous distance to the south. Although these marches must be looked upon as perfectly fabulous, still there is no doubt that they actually did penetrate far into the interior, but I should think they certainly did not go to Bornu, because if they had done so they would hardly have failed to mention the lakes.

Mr. CUST: Where do you place the River Ghir which Ptolemy mentions?

Mr. BUNBURY: Ptolemy's ideas of the geography of this part of Africa were perfectly confused. He got hold of names without knowing anything of their position, so that it is really idle to attempt to identify them.

Major GRIMSTONE: When Colonel Rhodes spoke of this water running into the

desert, you must recollect that that is salt water, and then he talks about it being connected with the Niger, the Niger being fresh water. Thus you either render the Niger salt, or the Niger would send its fresh water into the desert; but surely it would be better to let the fresh water into the desert instead of the salt.

Colonel RHODES: That is what I mean. There would have to be a canal from the Niger to the depression of the Sahára, so that at a certain time of the year, when the Niger floods as the Nile does, a quantity of fresh water would be supplied to this south end of the depression, and would help to feed the inland sea.

General Sir BEAUCHAMP WALKER: I think before we break up, as Sir Henry Barkly is not a member of this Institution, it is only due to him that we should return him our thanks for having done us the honour of taking our chair.

Lord CHELMSFORD: There is also another important part of our duty, which is to give a hearty vote of thanks to the lecturer. I am sure we all feel extremely indebted to him. I have listened with the greatest interest and attention to what he has said; and although I know nothing of the country he has spoken of, still it must be always of great interest to us, and we thank him very sincerely for his lecture.

Wednesday, June 18, 1884.

ADMIRAL SIR FREDERICK W. E. NICOLSON, Bart., C.B., Vice-President, in the Chair.

SIR WILLIAM THOMSON'S SOUNDING MACHINE: ITS ADVANTAGES IN PEACE AND WAR.

By Captain CLAUDE E. BUCKLE, R.N.

(Read by Captain S. LONG, R.N.)

The CHAIRMAN: Captain Buckle, who prepared this paper, has been appointed to a ship on foreign service, but Captain Long has been kind enough to undertake to read it for him. I believe Captain Buckle has had considerable experience in the actual use of this machine, and therefore his paper ought to be valuable as showing us the practical application of Sir William Thomson's invention.

I PROPOSE to divide the subject into two parts, viz., Peace and War; to demonstrate the advantage of having this sounding machine on board ship in both cases, and the very serious disadvantage of being without it.

The advantages of Sir William Thomson's sounding machine are:—

1st. Practically perfectly correct and reliable soundings in any weather, and in any sea.

2nd. Soundings at considerable depth can be obtained at a high speed.

3rd. That a ship need never be off her proper course for one minute for the purpose of obtaining soundings.

4th. That by running a line of soundings a ship's position can at all times be known with certainty, provided the charts are accurate.

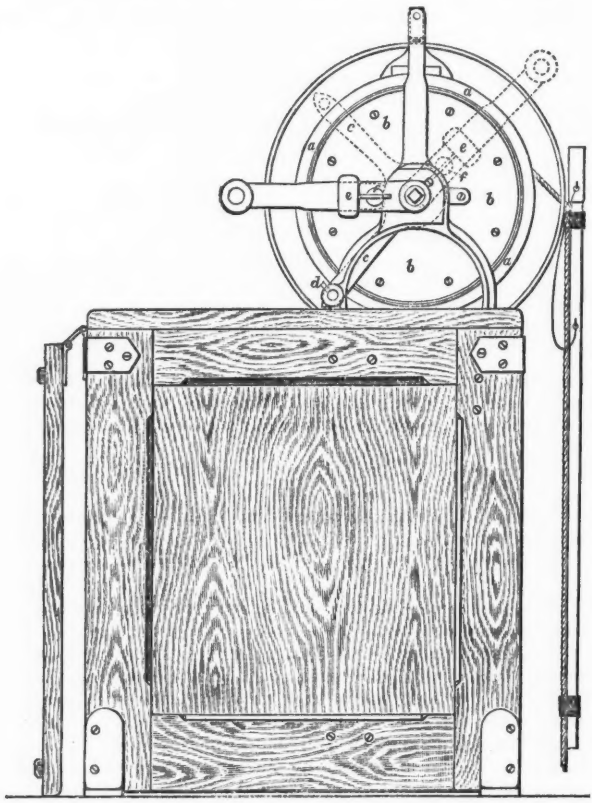
5th. That by frequent use of this sounding machine in fogs, vessels can with much greater safety continue at a moderate speed, and greatly decrease the danger of collision in narrow waters.

I think I should waste time by entering into a very full description of either the original or later invention (for which I refer you to the Journal of this Institution, vol. xxv, No. CX),; but I will confine myself principally to consider the apparatus as now supplied by Sir William Thomson.

The original invention has been improved upon, and is that now in use. The later invention, though successful, had one important drawback—it was expensive. The sounding apparatus and indicator were combined, and if lost, you lost an article that cost 6*l*., and could sound no more, unless you had a spare apparatus.

The instrument as now made consists of a drum on which is wound fine steel piano wire, fitted into a frame. This must always be kept, when not in actual use, in a water-tight box containing lime and water. Attached to the end of the wire is an iron ring to which is

LATEST FORM OF SIR W. THOMSON'S SOUNDING MACHINE.



The wire is coiled on the drum or wheel a, a, a. This drum can rotate independently of the axle, or it can be clamped to the axle and made to rotate with it. The arm c is attached to a nut, which works in a screw on the axle. When the arm c is held in a fixed position by means of the bolt d, and the handle is turned in the direction for paying out the wire, the disc b, b, b is loosened from the drum, and the drum is free to turn round independently of the axle. When the handle is turned in the direction for winding in the wire, the disc is tightened up, and the drum is clamped to the axle.

As soon as everything is ready for a cast the handle is turned in the direction for paying out the wire. This releases the wire-drum, and allows the wire to run out. As soon as the sinker reaches the bottom the handle is turned in the direction for hauling-in. This clamps the wire-drum to the axle and prevents any more wire running out. The bolt d is then withdrawn, and the winding-in of the wire proceeded with.

secured a plaited rope. To this rope is seized in the centre a brass guard tube, and to the end of the rope is attached the sinker, having a hole at the bottom for the arming.

Into the guard tube is introduced a glass tube, hermetically sealed at the upper end, open at the lower, and coloured internally by chromate of silver.

When ready for use, the wire is taken over a fair-lead on the stern-rail, and the sinker lowered down over the stern. By lifting the brake the sinker descends rapidly, the water forces its way into the glass tube, gradually compressing the air in it, and decomposing the chromate of silver.

When the sinker is seen, or felt by the slackening of the wire, to have reached the bottom, the brake is put on, the wire is wound in, the tube taken out of the guard, arming examined, and placed in the scale (care being taken never to let the tube get out of the vertical position). The closed end of the tube is pressed against the brass plate on the top of the scale, and the depth of water is read off by the line in the tube, showing where decomposition of the chromate of silver has ceased.

Although I have never worked with the present improved machine, the principle is so much the same, that I do not think the difference in fittings need be considered.

Thanks to Sir William Mends, I got one fitted to H.M.S. "Assistance" in 1879, and had nearly three years' work with it. During that time, I think, we only lost one sinker, with a small quantity of wire; and this from no defect in the instrument.

On inquiry, I find that both the original machine, the improved, and the "improved original" are largely in use in the mercantile marine, while a small number are in use in the Royal Navy; but the present machine, "the improved original" as I term it, is that most in favour.

I can imagine nothing better or simpler than the glass tubes. With care they will keep without serious deterioration for two or three years. Certainly, I had some in H.M.S. "Assistance" for over two years, and I think only one or two lost their colour to any extent.

Before giving my own experience, I will mention that I have been in communication with a large number of the principal shipping firms, and only two of those communicated with do not use the machine.

H.M.S. "Assistance" is employed to carry troops from port to port in England, Ireland, Scotland, and the Channel Islands; the greater part of the work being done during the winter months. Much bad weather, gales, and fogs were experienced, and the lead was in frequent use. When, to my great satisfaction, Sir William Thomson's sounding machine was first fitted, an Officer of great experience shook his head over it, advised me not to trust it, and enumerated various defects. This somewhat damped the feelings of the Navigating Lieutenant and myself, but, being both believers in the machine, we determined to give it every trial. We soon found that, at any rate, we got very good soundings by it; but it was not till we found

ourselves in a dense fog off Alderney, standing off and on, that we realized what we owed to Sir William Thomson. Shortly before 8 o'clock the Navigating Lieutenant ran below to wind up the chronometers, and I went aft to sound, prior to reversing our course. My first soundings gave 70 fathoms, which surprised me. Immediately replacing the same tube I sounded again, getting 90 fathoms. I changed the tube, and got a decrease. I at once went to the bridge, looked at the chart, and saw we were undoubtedly crossing "Hurd's Deep," a long narrow deep off the Casquets. As I put the helm over to stand out, the Navigating Lieutenant coming on deck just caught sight of the Casquet Rocks under the fog, for we had been set to the westward more than we had expected. After this we never doubted Sir William Thomson's sounding machine, but felt it was a guide, counsellor, and friend.

On another occasion, when off the Land's End on a winter's night, we were caught in the most severe gale I ever experienced in the "Assistance." The wind was from S.E., backing, and weather very thick. We were bound for Kingstown, and having the ship very full with troops, women, and children, I decided to shape my course for Holyhead. We therefore steered for the Tuskar, sounding every hour or half-hour. We saw nothing of the Smalls Lighthouse or Tuskar, the weather being too thick, so we steered for Bardsey Island, so as to keep a weather shore; but before making Bardsey, the wind flew round from N.E. to N.W., and I then decided to steer for the Codling Lightship. So satisfied were we of our position by soundings only, that we calculated the exact time, as the weather was clearing, that we should see the light, and we did actually see it within 10 minutes of the time expected.

I think this case proves that our soundings were correct and reliable; they were obtained without stopping the ship once, and the depth varied from 40 to 60 fathoms. By keeping a line of soundings we always knew our position, and thus were able to avoid "lying to," and the consequent risk of being run into.

I could name an ironclad that some time after this was making for the Irish Channel, and got into bad weather between the Land's End and Tuskar. Not liking to try for the Tuskar she had to lie to and wait till the weather cleared.

I need scarcely say she had no "Thomson" on board, and I should think, between coal and knocking about, she cost the country quite one-half the first cost of Sir William Thomson's sounding machine. You will of course suppose she is possession of one now.

Another time, bound for the Irish Channel, we were caught in a dense fog when steering for the Lizard from the Start. We decided to run a line of soundings to a certain depth off the Lizard, and then to alter course to clear the outlying rocks off that point. So accurately did we carry this out, that we got our exact soundings, altered course, heard the siren, and actually saw the sea breaking on the rocks, by looking under the fog, our heads being level with the rail.

Later on in the commission I mentioned this case to a Navigating

Officer who had just joined, and found that he had heard of it, and also that we had found ourselves closer to the rocks than we had intended. I soon proved to this Officer that we had worked on a principle, and had never run the slightest risk.

I think in this case you will see the enormous advantage of the "Thomson" in a fog at such points as the Lizard or the Longships, Tuskar, or any turning points in navigation. Instead of having to stop and poke about to get hold of something—a lighthouse, fog-horn, siren, or lightship, a vessel may proceed steadily on her course. If all vessels could do this when moving up and down the Channel (Channel groping, as it is well called), how many disasters would be avoided—how much fewer would be the number of collisions in fogs—how much less property lost—and what a decrease we should have in the loss of life, and the consequent misery and suffering to widows and children.

Whilst so many strides have been made in guns, arms, torpedoes, and in the art of killing, I know of no invention more calculated to save life and property afloat than Sir William Thomson's sounding machine; and, considering the enormous cost of building ships, surely it is worth while to expend 25*l.* on an instrument which would so greatly contribute to their safety.

I must apologize for giving you so much of my own experience, but I think facts are better than hearsay evidence, and I hope I have pretty well proved, by my personal experience alone, the advantages of Sir William Thomson's machine in time of peace. But, before I turn to the second consideration, viz., the advantage in time of war, I would mention that the great number of large shipping firms with whom I have been in communication on this subject almost unanimously speak in the highest praise of this invention. A Captain in one line of Atlantic steamers says, "I would not take command of a ship in that trade without a 'Thomson;'" and an Officer in command of a P. and O. steamer goes so far as to say, "he would sooner go to sea without his chronometers than without his 'Thomson.'"

I have heard objections raised to this most valuable instrument on account of alleged defects, such as kinking and breaking of the wire, discoloration of tubes, and the failure of the brake. If the instructions sent with the sounding machine are followed, none of these defects will arise. When they do, it is entirely due to the want of knowledge on the part of those working the machine.

Men must be instructed in the use of this, just as well as in other machines. But the instructions sent with it are ample, and a very short course of instruction suffices. It can be given with the ship at anchor in a moderate depth of water.

In the "Assistance" by day, the work was generally done by the boatswain's mate of the watch, one seaman, and the soldier on the life-buoy, or a soldier reeler (if not too sick). By night a seaman took the place of the soldier. As a fact, I very often took the soundings myself, but solely as a matter of interest, not from any necessity.

It is of course well known that vessels do, as a fact, frequently run in fogs at a very high rate of speed, and I have heard it objected

that this invaluable sounding machine will still further tempt Officers to run at a dangerous speed. I do not see the strength of the argument, but if you cannot check the high speed, surely it is better to provide every possible safeguard—and a safeguard is certainly found in providing a machine that will enable Officers to run a line of soundings, and know where they are going, rather than let them run blindly on, risking everything, to avoid losing the time taken in sounding by the old system!

To us in the Royal Navy, "Watch, pass the line along!" was never a welcome sound; but consider what it means in short-handed steamers, rolling about in the trough of a sea, with floods of water rushing to and fro on the decks! Think of sailing vessels making for the Channel, or working down Channel with the crews they now have; consider what sounding means to *them*: shortening sail, and rounding to for *one* sounding, and then making sail again—all hands perhaps wet through in doing it. Can it be supposed that an Officer in command of one of those splendid four-masted sailing ships, homeward bound from Australia, India, or the Pacific, making for the Channel with a fair gale and thick weather, will feel much inclined to heave-to repeatedly to sound, when once he has passed the 100-fathoms line? Does he not try and shove on, though possibly doubtful as to his exact position, and the country is startled by the news of a terrible disaster at sea, and many homes are made desolate by the loss of lives unnecessarily sacrificed.

If owners would but see it, there is available for their ships a substitute within the 100-fathoms line, for lighthouses, buoys, and beacons, and their ships would be steered in safety until a pilot was secured! What Officer who has served in Her Majesty's sailing ships, or has handled the long ships of the present day under sail, fails to remember the amount of labour entailed, the number of men wet to the skin, and often damage to the ship, caused by rounding-to in a gale of wind or strong breeze, to get soundings, to say nothing of the loss of time and position incurred in the process?

Some of us, I daresay, have heard of vessels finding themselves off Lundy Island instead of off the Start, but with a "Thomson" on board I do not think such a mishap would be possible, provided always a line of soundings were carried out, beginning, say, at every two hours, and decreasing the intervals as water got less and the land was neared.

It is useless to put off sounding until near danger. The method of a line of soundings should be the rule, and only by that means can perfect confidence be gained.

I know of one instance where a flag ship on a foreign station, fitted with a "Thomson" of the condemned pattern, lost the sounder, and not having a spare one on board, the Admiral had to depend for soundings upon an Officer in command of another ship, who had purchased one at his own expense.[1]

[1] This instance also showed the great advantage of being able to sound when sailing or steaming at a high speed in line ahead, which can be done without checking the speed of a squadron.

Certainly, all ironclads are having them fitted as they recommission. Many ships, however, recommission abroad, and so do not get them; but I would have every ship in Her Majesty's Service fitted with one, and I am sure that it would be equally desirable that all vessels employed in the transport service should be supplied with it.

An Officer who used the apparatus for six years when in command of a steamer running between England and the United States, says: "Carrying mails and passengers as we did, it was important to make a quick passage and at the same time incur no risk; I had therefore to run sometimes nearly 1,000 miles by the lead alone; and as with Sir William Thomson's machine there was no need to stop for a cast, I took one every two hours, noting log." A most useful instrument in connection with Sir William Thomson's machine is the taffrail log. The same Officer states that he found the soundings of the United States survey beautifully accurate, but those to the eastward were in some instances incorrect, and the banks badly defined. By the aid of a "Thomson," this Officer brought from Belfast to Liverpool a new steamer, 430 feet long, when the fog was so dense that no fewer than six coasting steamers ran ashore; and several times a conversation was held between those on board the steamer and those on board other vessels that could not be seen! Notwithstanding the denseness of the fog, the bar lightship was made, and the vessel successfully taken up the Mersey.

When you consider the work done by Her Majesty's ships in all parts of the world, I think much useful information might be gained if Officers made use of the "Thomson," and reported the result. I find that some of the Commanders of the Atlantic steamers keep a regular record of their soundings in crossing, and some keep specimens of the bottom when they can be detached from the arming.

For myself, I cannot but think that this invaluable invention should be seriously considered by the Board of Trade and all insurance offices; vessels over a certain tonnage should be made to carry and use it. I believe that much might be done to reduce the number of collisions in the English Channel and round the coasts of Great Britain if vessels steering to the westward were made to keep in one line of soundings, and vessels bound east in another line.

All the advantages that I have adduced in favour of Sir William Thomson's sounding machine in time of peace are doubled, nay, trebled, in time of war. A squadron or a vessel on approaching an enemy's coast might find lights extinguished and buoys and beacons removed. The whole success of an expedition might turn upon the arrival at a certain point at a given time of a fleet of ships of war and transports laden with troops. Time is precious, troops are urgently wanted, and thick weather comes on. Now, unless every vessel is able independently to keep her position by soundings, delay is inevitable. Each vessel is compelled to depend on her own resources, and what, I may ask, in such a case could be of more infinite value than a "Thomson's" sounding machine? Should there be a limited number only of these machines in the fleet, the endeavours to make known

the soundings by siren would inevitably lead to confusion and discovery to the enemy. Consider the case of a ship-of-war in chase of a vessel, the weather thick, lights and buoys removed. Can there be any doubt as to the result of a chase in shallow waters and dangerous ground, provided one vessel carries a "Thomson" and the other does not? Give it to the vessel chased; she will carry her line of soundings, know her position, lead her enemy into danger, and probably wreck her, while she will be safe herself, unless indeed the Commander of the chaser is prepared to go blindly on, for of course when once he stops to sound by the old system the chase may be said to be over.

Take again the case of a vessel conveying important information to an Admiral or the Admiralty, and making up or across the Channel in a fog. She certainly will not decrease speed if she can avoid it, and the necessity of sounding need in war be the only check on speed in any emergency. With Sir William Thomson's machine a vessel would carry a line of soundings for the nearest telegraph station, and run without stopping. Without a machine a vessel can only run up to a certain time, when she must sound; her position even then is uncertain, and time, of all things valuable in war, will be lost.

How often in war time it becomes necessary to get a line of soundings off some fort or well-guarded position. To do this with the old hand lead would be fatal, whilst a "Thomson" might be fitted to a boat and soundings taken either by day or by night in a very short time.

Captain Singleton, of H.M.S. "Jumna," told me that he found Thomson's apparatus invaluable amongst the shoals and reefs in the Red Sea, in the vicinity of Suakim and Trinkatat. Also Staff-Commander Cole gave me a most interesting description of the navigation of the "Northampton," flying the flag of Sir Leopold McClintock, when in dense fogs on the North American Station. It is well known that at certain times of the year the Baltic is subject to dense fogs; and I need scarcely say that the Russians, with their usual appreciation of advance (whether scientific or otherwise), have provided all their ships with a Thomson's sounding machine. The French have not been behindhand in securing this important invention for the benefit of their Navy; and I have heard of a French squadron making remarkable use of it, each ship working her own machine.

If foreign Powers so thoroughly appreciate this valuable invention, should not we, who have the honour of claiming the distinguished inventor as our countryman, accept with pride and gratitude the priceless boon offered us, as a sure and certain guide for the sailor in the most difficult and dangerous portion of his voyage?

I must plead your kind indulgence for the many defects in this paper, but a sudden call to active service has prevented my bestowing all the time and labour I could have wished on a subject I take so deep an interest in, and which so vitally concerns the shipping interest of this great country.

I maintain, in conclusion, that of late years no man has done more

for the safety of the mariner than Sir William Thomson by this invention, and to him are due the grateful thanks of all "that go down to the sea in ships, and occupy their business in great waters."

APPENDIX.

CORRESPONDENCE.

Letters addressed to Captain Claude Buckle, R.N., on Sir William Thomson's Sounding Machine.

No. 1.

The University, Glasgow,
March 18th, 1884.

Dear Capt. Buckle,

I have received your letter of the 14th, and thank you very much for the kind interest you take in my Sounding Machine. I cannot but agree with you that it is not sufficiently used even in ships provided with it, and that those who have it, have not been sufficiently instructed to allow them to use it with intelligence. A few days ago I heard from an Officer (only a soldier however) who has seen it used in the * * * that they could not use it at night, because they had not light to read the scale! "Kinks in the wire" *never* occur when the brake cord, &c., are used according to the printed instructions.

My nephew (W. Bottomley) will send you some printed papers and references regarding the Sounding Machine. If there is anything else in the way of information or otherwise we can do in respect to your paper at the United Service Institution, we shall be most happy to do it. If you would like to have a Sounding Machine to show, we shall have one sent, with specimens of gauge tubes as actually marked for different depths.

Believe me,
Yours very truly,
WILLIAM THOMSON.

No. 2.

The University, Glasgow,
March 24th, 1884.

Dear Sir,

In reply to your letter of the 20th, the price of the Sounding Machine which we now make is 25*l.* This machine is used with either the glass tubes or the depth gauge, but very few of the depth gauges are used now, and almost all the machines have glass tubes supplied with them.

The glass tubes answer very well, and we find that sailors do not like to trust the depth gauge to the wire for fear of the line carrying away. They prefer to have a supply of the glass tubes on board. If the line breaks and they lose a glass tube and sinker, it is not a serious matter as regards expense. We always recommend the glass tubes now, as we think it most important that sailors should not have any hesitation in taking a sounding at any time. The depth gauge is an expensive instrument, costing 6*l.*, and if sailors know there is a chance of losing 6*l.* in taking a cast of the lead, they would be inclined to put off sounding as long as possible.

If you are in London you can see the present form of Sounding Machine at Messrs. Lilley and Son's, 9, London-street, Fenchurch-street, London, E.C. It is probably different from the one you had on board the "Assistance."

I think your paper for the United Service Institution might be made very interesting if you were to give your experience on board the "Assistance," and urge on the Institution the importance of frequent soundings before there is any chance of the ship being in danger.

Many sailors would be saved a great deal of trouble and anxiety if they made a rule of always taking soundings periodically when they are in water of 100 fathoms or less, whether the weather is clear or thick.

Yours truly,
W. Bottomley, Jun.

No. 3.

The University, Glasgow,
March 28th, 1884.

Dear Sir,

I have received your letter of the 26th, and am much obliged to you for telling me what the Captain of the "Yucatan" says.

I believe he is right in saying that damp does injure the chromate of silver, but if the tubes are properly looked after and kept in a dry place, they keep good for a long time. The salts of silver are rather easily decomposed if exposed to light, and if we could get another more stable chemical as suitable for the work as chromate of silver, we would use it.

The mark is made by the action of the salt of the sea water on the chromate of silver, so that brackish or fresh water will not act on the tubes. If it were necessary, we could prepare special tubes for fresh water. We would then coat the tubes with prussiate of potash, and put some solution of sulphate of iron into the guard tube. The sulphate of iron would rise in the glass tube with increase of pressure, and acting on the prussiate of potash would coat the tube blue. This was the original way of coating the tubes, and it answered very well, but there was the trouble of always putting some solution of sulphate of iron into the guard tube. The chromate of silver tubes could be used in fresh water by plugging up the hole in the guard tube and putting some salt water in it before taking the sounding. Many sailors object to the rope brake, but I don't think they have any good reason for their objection, except that it is a new thing for them. From our experience of it, we think it works very well indeed.

We are just now experimenting with a new brake which, if successful, the sailors may like better, as it has not the rope.

The wire bears about 8 or 9 times the greatest strain that is put on it, even with a sudden check, and I don't think it would ever break with a fair pull in practice, unless it has a kink or has been allowed to rust through carelessness.

In many cases where it has been properly kept, it has lasted for two or three years.

Yours truly,
W. Bottomley, Jun.

No. 4.

Continuous Use of Sir William Thomson's Sounding Machine for Rapid Soundings, when near shore or within 100 *fathoms in Thick Weather.*

Keep the machine going incessantly; two men working it and one to relieve.

As soon as the sinker comes up, let it go again without using a glass gauge tube every time. Judge the depth as well as you can from the length of the wire out, as shown by the counter.

Use a glass gauge tube every third or fourth cast, or not so often, or oftener, according to judgment.

No. 5.

Peninsular and Oriental Steam Navigation Company,
Offices, 122, Leadenhall Street,
London, E.C., 18th March, 1884.

Dear Sir,

In reply, we beg to say that Sir William Thomson's Sounding Machine with tubes, which has quite taken the place of the old deep sea lead, is in constant use on board all the steamers of our fleet, and gives the utmost satisfaction. The reports

received from the Commanders and Officers bear undeviating testimony to its practical value.

Yours faithfully,
F. R. KENDALL,
For the Managing Directors.

No. 6.

Peninsular and Oriental Steam Navigation Company,
Offices, 122, Leadenhall Street,
Dear Sir, London, E.C., April 14th, 1884.

In reply to yours to the Secretary of yesterday's date, *re* sounding with Sir Wm. Thomson's Sounding Machine, I beg to say that although it is used throughout our fleet, and is well spoken of and highly valued, at the same time we discourage our Officers from relying implicitly on soundings taken at a high rate of speed, with a great depth of water, and require them to be cautious in this respect, when necessary.

My own opinion and experience is, that the instrument may be used at a speed of 10 to 12 knots. With soundings of from 40 to 50 fathoms with increasing depth, the speed must be proportionately reduced. This rule is generally followed by my brother commanders.

It is a most valuable instrument, but must be used with intelligent seamanlike judgment.

I am, dear Sir.
Faithfully yours,
JOHN C. ALMOND,
P. and O. S. N. Company.

No. 7.

Union Line.
Cape of Good Hope, Natal, and East African Royal Mail Service.
Union Steam Ship Company, Limited.
Dear Sir, Southampton, 18th March, 1884.

In reply to your separate letter on this subject, *all* our ships are fitted with Sir W. Thomson's Sounding Machine, and I have heard no opinion expressed adverse to their use. I do not know *which* machine is supplied, but I understand it is the one described in enclosed pamphlet. I return Captain Buckle's letter.

Yours truly,
W. R. DIXON,
Superintendent.

No. 8.

Mississippi and Dominion Steam Ship Company, Limited,
Harvey Buildings, 24, James Street,
Dear Sir, Liverpool, 28th March, 1884.

Your favour of yesterday to hand, and in answer beg to say that we showed your letter to Captain F. B. Bouchette of our steamer "Montreal," and Captain C. J. Lindall, s.s. "Sarnia," and they both speak very favourably of Sir William Thomson's Sounding Machine. Each of these Commanders is in the Montreal trade, during the season, and say they have never experienced any difficulty in obtaining soundings in any portion of the St. Lawrence.

None of our New Orleans Commanders are in port at present.

Yours truly,
FLINN, MAIN, & MONTGOMERY.

No. 9.

White Star Line.
34, Leadenhall Street, London, E.C.; 37, Broadway, New York.
Dear Sir, 10, Water Street, Liverpool, 18th March, 1884.

In reply to your inquiry addressed to our London Office, we beg to state that

Sir William Thomson's Sounding Machine has been in use for deep-sea soundings on board of the White Sta- ships for a very considerable time, and has been found to give very satisfactory results.

In approaching the land, however, in thick weather, the Commanders are required to take frequent soundings with the lead quite regardless of the delay which may be thereby occasioned, using the patent as an auxiliary check only.

Yours faithfully,
ISMAY, IMRIE, & Co.

No. 10.

Allan Line, Canada and United States Royal Mail Steamers.
City Line of Steamers to Calcutta and Bombay.

Dear Sir, 19, James Street, Liverpool, 18th March, 1884.

In reply to your favour of 14th instant, Sir William Thomson's Sounding Machine is in use in all our mail steamers, and is very highly spoken of. We have the first machines in use, but we are aware the more recent ones have been considerably improved.

Yours truly,
R. THORN.

No. 11.

Allan Line, Canada and United States Royal Mail Steamers.
City Line of Steamers to Calcutta and Bombay.

Dear Sir, 19, James Street, Liverpool, 29th March, 1884.

Our Superintendent informs us that he has frequently used the machine in the St. Lawrence, and found no difficulty getting soundings, relying more on the pressure than on nature of the water.

Yours truly,
R. THORN.

No. 12.

Pacific Steam Navigation Company,

Dear Sir, 31, James Street, Liverpool, 21st March, 1884.

. . . . . I have now to say that Sir William Thomson's Sounding Machine is in use on our ships, both the old and later type, and has given very great satisfaction, the Commanders reporting highly of the latter, and also of the older type of machine.

Yours faithfully,
J. W. WILLIAMS.

No. 13.

James Moss and Co., 31, James Street,

Dear Sir, Liverpool, 17th March, 1884.

We have had only one of Sir W. Thomson's Sounding Machines in use on board our steamers. It was supplied to the "Canopus," then running between here and Boston, and was reported on very favourably as registering correct soundings while the ship was going at full speed.

Yours truly,
JAMES MOSS & Co.,
Per G. S. Cook.

No. 14.

Dear Sir, Formby, Lancashire, 20th March, 1884.

In reply to yours of the 17th inst., I have to state that I commanded a trading steamer in the Liverpool and Boston trade for above two years, during which time I constantly used Thomson's Sounding Machine, and outwards and homewards I took the Northern passage, *viâ* Cape Race, which I dare not have done without this valuable patent. I regret having parted with my soundings, or I would have sent

them to you, and I had an interesting collection of some hundreds of samples of the bottom taken up to 120 fathoms, and by using an arming of white lead, I have been able to bring up a small stone at the above great depth, and after comparing samples of one voyage with a following one, I could make a certainty of the position; for example, off Sable Island, you have between 70 and 20 fathoms three different kinds of sand, the very fine being on the shoal water. I seldom lost a sinker with any old hand at the work, and with a careful watch to stop the running, and directly the bottom was touched, there was no fear of the wire giving way, and should the bottom prove to be rock, on placing the white lead arming under a strong glass, there was the indent marked to assure me of correct soundings. I never made but one mistake whilst using this machine, and that was under the following circumstances: whilst running out of the North Channel during a thick fog at full speed, say 12 knots per hour, and with hardly two men in the watch for this kind of work —say chief officer on the bridge, myself on the saloon deck (deck under the bridge), another man to listen from the lower deck, the usual two lookouts forward, with third officer at the cord, to see that course was made good. I was approaching the Narrows when I relieved the third mate with the boatswain, and sent that officer to get a cast of the lead. He came back and reported that he was not sure, but he thought he had soundings. I took the arming into the chart room, put it under the magnifying glass, and could see no trace of bottom, and thinking the young man was strange to the machine, I ordered another cast at once, and for fear of any mistake, I gave the order to stop the engines to give time to verify soundings. Unfortunately just then a steamer's gong was reported from forward on starboard bow, and for fear of stopping athwart hawse of another vessel, I gave the order to keep going till we passed, and the consequence was running on shore on Cantyre, the signal there, Sanda, though advertised as per Admiralty List as a siren, proving to be nothing but a steamer's gong, and though the Board of Trade brought the maker and the man who worked the machine, they only gave evidence in my favour, and the President of Court of Inquiry said I had evidently been trapped, as the maker and keeper declared the gong was not to be known from an "Anchor" steamer's whistle, and they agreed it was not regularly sounded. I was clear of blame. Here you have a case of what some people would call reckless navigation and full speed in a fog, and neglect of lead would most likely have gone against me, but for producing my samples of soundings, and here was evidence for the Court of an experience of use of the lead that they had never seen before. But to come back to cause of no sign of bottom: it appeared that there was a vegetable growth of some 8 feet that prevented in this, the only case I ever met with, the sinker showing it had been down, and here was no fault in the machine, and any old hand could have at once said certainly bottom. The great advantage is of course in being able to get the soundings at full speed, and there was no necessity to ease down even at 100 fathoms. My own experience is that I would not have taken command of a vessel in that trade without Thomson's Sounding Machine, and it would be dangerous work to attempt the Northern passage without such a simple, easy way of getting soundings. Of course I had the old machine, and I considered that perfect, and as regards comparison of soundings got with those of chart, they were nearly identical in from 75 fathoms to less, but in the gully between Cape Race and the Great Bank, I found more water than as per chart, and more variation, say from 90 and above 100 fathoms, but I am not at all sure but that my variable soundings were not the more correct of the two, and there was at anything over 90 fathoms a certainty of being in the track. I have written you fully, but if I can collect you further information from the masters of the mail steamers, who all use this machine, I shall be glad to do so on again hearing from you. Meanwhile I am

Yours truly,
ALFRED HORSFALL.

No. 15.

Anchor Line of Steam Ships,
Henderson Brothers, 45 and 47, Union Street,
Glasgow, 19th March, 1884.

Your note of 14th inst. has been forwarded to us by our Liverpool firm.

Sir W. Thomson's Sounding Machines are used on board all our Atlantic steamers, and we have found them of very great service. The old machines required to have the tubes refilled every time they were used, but the improved one which we have now adopted does not require this, and is the best sounding machine we know of.

HENDERSON BROS.

No. 16.

The Castle Mail Packets Company, Limited. The Castle Shipping Company. The Liverpool and Hamburgh Steam Ship Company.

3 and 4, Fenchurch Street, London, E.C.,
Dear Sir, 27th March, 1884.

In reply to your note of the 26th instant, we beg to inform you that Sir William Thomson's Sounding Machine is used by our line, and that we use the glass tubes in preference to the apparatus with tubes and sinker combined, the former being more favourably spoken of by our Officers. We understand that Sir Wm. Thomson personally also prefers the former apparatus.

We are, dear Sir,
Yours truly,
DONALD CURRIE & Co.

No. 17.

Messrs. Gray, Dawes, and Co.,
Agents, B. I. S. N. Co., Limited.

13, Austin Friars, London, E.C.,
Dear Sirs, 22nd April, 1884.

In reference to the enclosed letter from Captain Buckle, R.N., my experience of Sir W. Thomson's Sounding Machine, which I invariably use, is that 80 fathoms can be attained at 10 to 11 knots speed. I have never had occasion to take a deeper cast at such a high rate of speed.

I can always rely on the soundings. A defective tube fills with water, and is easily detected, all the colouring matter being washed out. I have always found a small percentage of the tubes fail to keep their colour, but so small as to be practically of no account.

I have never found the climate to affect them, at least during the time when we have them in stock, say 12 months.

I remain, dear Sirs,
Yours faithfully,
(Sd.) J. C. SHARP,
Commander s.s. "Goorkah."

No. 18.

The National Steam Ship Company, Limited, Drury Buildings,
Sir, 21, Water Street, Liverpool, 18th March, 1884.

In reply to your note we use Sir Wm. Thomson's first Sounding Machine (reel-wire and glass tubes), and same is well spoken of by our Captains.

Yours truly,
J. G. LANGLANDS,
General Manager.

No. 19.

The Orient Steam Navigation Company, Limited,
13, Fenchurch Avenue, London, E.C.,
Dear Sir, 17th March, 1884.

In reply to your letter of the 15th inst., we have Sir William Thomson's Sounding Machine in our two newest steamers, the "Austral" and "Orient," and it is very well reported on; the only drawback to its use is the uncertainty of getting the soundings, owing to the wire breaking; it is not therefore thoroughly to be

depended upon. The old lead and line should always be on board and ready for use.

Our machine is the original Sinker; the improved one is considered too expensive.

Yours faithfully,
S. WAYMOUTH,
Secretary.

No. 20.

Extract from Letter of a Captain, R.N.

"Take the case of a long steamer running at speed, how much ground she would have to pass over to get a reliable cast under the old system, necessitating deadening of her way, whereas the 'Don,' West India Mail steamer, going 15 knots, got soundings in 70 fathoms with Sir William Thomson's Sounding Machine, with two men only."

No. 21.

Extract from a Letter of a Staff Commander, R.N.

"I am glad to say that I can give you any information you may require about Sir William Thomson's Sounding Machine.

"We had two fitted on board H.M.S. * * * during the whole commission, and as the fogs in North America are very dense and frequent, you will readily understand that our experience in the use of these machines was by no means small. I consider it to be one of the most useful instruments ever supplied to a ship. It is invaluable—in fact, when a man knows and experiences how extremely simple it is in its working, and accurate in its results, he shudders to think of the amount of labour that was required to get a line of soundings with the old deep sea lead and line.

"Of the two kinds, I very much prefer that with the chemically prepared tubes; we had them in the * * * ; the only objection is that the chemical preparation deteriorates with age. We left England with a large supply of glass tubes, which lasted during the whole commission. During the last year, however, the red colour in the tubes became rather indistinct; but only in a few cases was it necessary to change the tube and take a second cast.

"The great advantage of the glass tube is that each one may be considered a separate sounding apparatus; for instance, if the line carries away, and the sinker and tube are lost, it is simply necessary to bend on another of each, and you are again complete; but with the new apparatus, if the line carries away the whole thing is gone, and you have nothing to fall back on but the old-fashioned, untrustworthy 'patent lead.'

"I pointed this out to Sir William Thomson last summer, and I understood him to say that he quite recognized it, and that the glass tubes would be again issued in preference to the new machine.

"I am strongly of opinion that Sir Wm. Thomson's Sounding Machine should be supplied to all ships. In fact, when the great advantages of simplicity, quickness in obtaining soundings, accuracy, and economy of labour, are taken into consideration, it is difficult to understand why this useful instrument has not been added to the establishment of every ship in the Service.

"If you have not been shipmates with it, I may mention that all the manual labour required to work it is two men besides the quartermaster, although the ship may be going at any speed."

Admiral Sir ERASMUS OMMANNEY, F.R.S.: The merits of Sir William Thomson's sounding mac ine are too well established to require any testimony either from me or anyone else, but still, having seen the utility of it, I may perhaps say one word. On one occasion when coming along in the "Sorata," one of the Orient line, at 15 knots'

speed, on entering the Channel off Ushant we fell in with a strong north-east gale of wind with very thick weather; we could hardly see a mile distance. They continued, however, to drive the ship 9 knots an hour against a tremendous gale and preserved her course, taking soundings without checking the engines in the slightest degree or making any deviation. We obtained accurate soundings every hour, and were able to make Plymouth Sound before sunset, thus saving the night, which was of very great importance. I am quite sure that had we not been provided with this machine we should have lost the night altogether. So accurate were the soundings, that the master had the greatest confidence in the navigation of the ship, and we made Eddystone Lighthouse with the greatest precision. I was greatly struck upon that occasion with the extreme value of this sounding machine to navigation; and I think no ship navigating along our coasts should be without it.

Captain CURTIS: We appear to be coming back to the old system of lead, latitude, and a good look out. We have constant fogs in the North Sea and in the Atlantic, and as the mail steamers cannot stop, I think the use of the lead and the registration of soundings is invaluable when obtainable. A steam vessel bound from Bilboa to the Bristol Channel had to make Lundy Island. In that case the caulker after caulking the decks at Bilboa was good enough to reverse the magnets, and the master of this vessel found himself off Ushant instead of off Lundy. If he had had one of these sounding machines he would have sounded and have detected his position sooner. On one occasion I was put in a gunboat in the Mediterranean, and had 24 hours' notice to go to Tripoli and Bengazi. The vessel had a set of men put on board of whom I knew nothing. I had to stow coal and provision her. I said I should like the compasses to be adjusted, but the master attendant told me gunboats' compasses never required any adjustment. I took him at his word, and started for Tripoli. It came on very thick when I should be off Tripoli, and I took soundings, standing off to 50 fathoms and in to 10 fathoms. I had to stand off and on a couple of days. I made out a marabout tower, but marabout towers are so much alike that that did not give me much information. We got there at last, and there I had to adjust the compasses. In coming back you do not get soundings at 100 fathoms between the mainland and Malta in mid-channel. There is a volcanic reef between Sicily and Malta, and this sounding machine, in making that channel, would be very useful indeed. As to the number of these tubes carried in surveying vessels, they should have a good supply. If a Quartermaster brought one of them up the companion ladder and someone came rushing down, in all probability, unless they were in a guard, they would be broken. I think, therefore, the tubes should be kept in racks or some kind of guard. I understand that the North Sea fishermen find their way about their fishing grounds entirely by the lead. They go in fleets from Grimsby and Hull, and I think if the Admiral's ship were provided with one of those instruments it would be a very good thing, and would relieve other skippers of a great deal of anxiety and trouble. When Sir William Thomson was explaining this instrument here, he said he could not get the ordinary deep sea lead down over the quarter of the "Livadia;" that the screw knocked it first to one side and the reflux to the other, it danced about in the rush of waters so madly that he had to provide a lead in the form of a steelyard weight before he could get it down. Mr. Bottomley, however, said that in an ordinary ship that lead answered every purpose. On the question of speed I cannot altogether agree with Captain Buckle, and although you have a sounding machine, I think certainly coming up the Channel in a fog you should not exceed 7 or 8 knots. You must keep a certain amount of way on a large vessel in order to have it in command. I have heard it said in this Institution that you should slow a vessel for ramming, but I should say give her as much speed as you possibly can.

Admiral BOYS: May I ask if Sir William Thomson's instrument is not on the establishment of stores of all ships?

Admiral CHARLES M. BUCKLE: I am well aquainted with this instrument, but I have not had much use of it. I should like for a moment to refer to a circumstance that occurred to me many years ago. I had to take a sloop I commanded at that time up the Talawan Passage from Labuan to Manilla. The weather was exceedingly bad; it was not only very thick, but it rained for 24 hours to such an extent as to be exactly the same as a fog. I went straight and went clear, but I had very great

anxiety, because during the whole time there was a strong head wind, and coral shoals were on either side, particularly on the off shore side, and if I had gone on one of those I should probably not have got off again. Sounding was continuous, and I remember on that occasion losing more than one lead and line in the dark by its happening to catch under a clutch outside the ship for the purpose of hanging a plug for the discharge pipe upon, and altogether I went through about as much anxiety in those 24 hours as could well fall to the lot of any Officer in command under similar circumstances. I did not stop the ship to sound, because her speed was very slow, and therefore there was no necessity for stopping. If I had had Thomson's sounding machine on board I should have been quite at ease, but as it was, I had a very anxious time of it.

Commander HULL: I think the thanks of the Service should be given to Captain Buckle for calling attention to this valuable instrument, as perhaps it may be the means of getting it more largely used in the Royal Navy. Since 1880 I have been in constant connection with the Mercantile Marine for the purpose of correcting their charts, and I find that hardly any well found steamship goes to sea without Sir William Thomson's sounding machine. All Captains in the Mercantile Marine who have used the machine, without any exception, speak of it in the same high terms as Captain Buckle has done. The attention of the modern naval Officer might perhaps be more alive to the important business of sounding and piloting. I think we have shown more energy on our guns and ships than on this affair of sounding. Guns on board ship, no matter how effective, are of little service unless the Captain is pilot enough to put his ship into a position to use those guns. The facility which this excellent machine of Sir William Thomson's gives to every sailor of obtaining that most important item in navigation--the depth of water he is in—and to use that knowledge and feel his way, as a beetle would use his antennæ, would not only prevent many accidents and much expenditure of coal, but would be of invaluable service in case of war. The remarks contained in the paper are so terse and so good that I can make but little addition to them. I am very pleased to see at the end of the paper the numerous testimonials from gentlemen of the Mercantile Marine and those connected with it, showing how thoroughly Sir William Thomson's machine is appreciated in our merchant navy, and I have no doubt when the paper gets into the hands of our new Hydrographer, something will be done towards the general supply of this much wanted instrument to the Royal Navy.

Sir ERASMUS OMMANNEY: I may mention one great advantage with regard to these tubes, viz., the valuable evidence which is obtained and which can be retained. If anybody is to be tried by court-martial, this tube can be produced, and that will give you the precise depth of water.

Captain C. JOHNSTONE, R.N.: I think the advantage of Sir William Thomson's machine is unquestionably recognized by every seafaring man: there cannot be two opinions with regard to that, and perhaps the small attendance here to-day may be accounted for by the fact that the value of it is so thoroughly understood that people may imagine that there is not much to be said on the subject. It far surpasses any other machine, and I certainly cannot imagine how any Captain can go to sea without one. It has been added by the Admiralty to the establishment of all ironclad ships, that is to say, the Captain can have whichever he pleases, Sir William Thomson's machine or the Massey. The chief advantage of this machine unquestionably is in deep water; in shallow water I suppose it would not be so convenient. It is in deep water that it shows a great advantage over the Massey, because the Massey cannot be depended upon at a great depth. I think this question of soundings has been somewhat neglected in the Navy; I do not mean to say that Naval Officers underrate the question of soundings, but all the details in connection with it have unquestionably been neglected. In 20 or 30 fathoms you can keep on sounding with Massey's lead with the greatest ease, but I think this is rather overlooked in the Service. I had the good fortune to serve a short time in a surveying ship, and my attention was drawn to the method of soundings adopted. There is the greatest possible difference between the method of sounding in a surveying ship and in any other. The leadsman sounds in a different way; the soundings with the Massey machine are carried on in a different way; and I think it is a very great pity that some improved system is not introduced into the Service.

Our present Hydrographer (Captain Wharton) wrote a book on surveying some time ago, in which he points out several defects in our present system, and I think it would be a very good thing if the attention of the Service were drawn to that. One especial point he there mentioned was that when the ship gets into shallow water and the leadsman is unable to get his soundings, that is to say, he has got so much line out that he cannot tell what his soundings are, he should invariably call out immediately "Shallow water!" He cannot read off his line, because there is so much slack, and he shouts out "Shallow water!" at once. That is the system generally carried out in surveying ships, but it is unknown in any man-of-war. I have had a little experience in this matter, for in making the Channel in a gale of wind when I commanded the "Liberty," we were a whole night trying to get soundings with Massey's machine, and at last, in the morning, we gave it up as a bad job, and made the best we could of it. We tried all we knew, but we could not get them: we ought to have had about 80 fathoms; but with Sir William Thomson's machine we could have got them immediately. There is one other point with regard to soundings in the Navy which I think is a mistake. I was told the other day by the Captain of a troop-ship which was bringing home men from service on the Mediterranean station, that a number of young able seamen who had been rated not a very great time before were put into the chains, but could not take soundings. Some were tried first and then changed, and others put in their place, but they also could not get proper soundings. He then sent for the petty officers, and said, "What is the reason that these men cannot get soundings?" They replied, "In the ship we come from they had selected leadsmen, and when the ship went in or out of harbour these selected leadsmen were put in the chains, and the rest of the able seamen never had a chance of getting soundings." It was only the selected seamen that were well up to the thing, and the able seamen did not understand it; so that these men were passing through the Service as qualified able seamen when, as far as soundings were concerned, they really were not, which is a great mistake.

Admiral SELWYN: We have recently had a Bill of great importance brought forward for the better regulation of the Mercantile Marine. It is extremely doubtful whether that Bill, in consequence of the opposition to it, will pass; but I am quite sure that if this machine is made a requisite fitting of every ship by the Board of Trade, more good will be done and more lives will be saved by Sir William Thomson's sounding machine, and the constant use of it, than could ever be saved by all the Bills that may be brought forward and passed. I should like to see a strong sense of responsibility abroad, and should like to ask whether if an ironclad is worth putting a Thomson sounding machine on board, every ship in the service is not worth it? Is 25*l.* more than a ha'porth of pitch compared to even a gun-boat? Knowing what we do about this machine for the last three years, it ought to be as requisite for a man to take this to sea as his compass or his chronometer. A ship ought as little to be left to go to sea without it as without a compass or chronometer. I cannot agree with many of my brother Officers about slowing up. I say distinctly the more ships slow up in a fog, the more ships there are to be in collision. A wise man always goes through a fog at speed, of course taking every precaution, but you will not find a single Officer of the great steamships running across the Atlantic who does not say, "I am far safer going 15 or 16 knots than I should be if I went 7 or 8 and stayed in the fog." If you consider what a fog is, and what delay would occur in consequence of slowing down to 7 or 8 knots, you might easily see that it is simply recommending a precaution to increase the number of collisions. There is no other view that is rational. The old system of slowing down might apply where we were all going at very slow speed, and where it did not matter whether we went 7 or 8, or 6 or 7 knots, or 5 or 6; but now it is a very different thing. A great improvement might be made no doubt in that respect by settling once for all, in narrow waters particularly, as has been once or twice proposed in the Channel, an up and down path; that is to say, steamers going down Channel should keep on one side, and steamers coming up the other side, generally speaking; but as for slowing down it is an error and a fallacy. With regard to this sounding machine, I should like to say one word about another machine brought before us by Sir William Siemens, because the two machines do not clash with each other in any

way, but on the contrary the one is not perfect without the other. Sir William Siemens's sounding machine takes the shape of a barometer, a weight measure. It can be kept in the cabin, and it gives us the depth of water underneath the ship's bottom at any moment by mere inspection without any soundings at all, to I think one-tenth of whatever the depth may be. I had this from Sir William Siemens himself, because I went into the matter, when he first brought it out, very closely with him. It is on an entirely different principle. One is an adaptation of the principle of the highest physics, that is to say, the consideration of what is the difference between the specific gravity in consequence of the attraction of the mass of earth or the mass of water, and the other is a machine beautifully adapted for its purpose, but which is not fitted to perform the function of telling you that you are nearing a coast or rocks. It has this other advantage that it is capable, by a very small modification, of being made automatic—by the attachment of a small constant electric battery, you can make it ring a bell whenever you are in soundings. It is no answer to say it only tells you within one-tenth of the actual depth, for this reason. Supposing I am carrying a line of soundings across the Atlantic, or any other sea, for the purpose of a cable, I do not want to know the depth very accurately, and one-tenth of the actual depth is of no importance. Take the other case, that in which I am coming in from the sea, and believing the ship in deep water I suddenly get into soundings without knowing it. It is of little importance to find that instead of being in 30 fathom soundings you are in 27; that difference is not of importance; the main fact is you have got out of what you believe to be an unfathomable ocean suddenly into soundings. I say the two things ought to be in the interest of the Naval Service and of the Commercial Marine requisites of the Board of Trade. No ship ought to be allowed to proceed to sea without these requisites, any more than without chart, compass, or chronometer.

Vice-Admiral SHORTLAND: We ought to be very much obliged to Captain Buckle for his very excellent paper. I should have been delighted if, at the time I had to do sounding work, such a machine had been put into my hands, when I should probably have done the work a great deal better. It is without doubt an excellent machine; it would be advantageous if we knew what are the limits of accuracy within which it will give the depth of water. We know that Massey's machines cannot be depended on very well, a blow on the fan blades will alter the rate of travel and change the reading of the index for a given depth, so that when using this machine I always tried it before and after using it; and at every time whilst sounding when an up and down sounding with the line could be obtained, the line was marked and measured, and the depth thus found compared with the reading of the index. I frequently found the soundings given by the machine a long way from the truth. Thomson's machine will also be liable to error, which will require to be determined, and this is what I should have been very glad to have heard something about. We now come to the point how hand soundings are taken in vessels of war and surveying ships. A man is no use in the chains if he gets too much slack line ahead of him; this shows he has not sufficient experience; the leadsman must have the line tight in his hand from the lead when it is up and down, by the lead coming vertically under him; if this is not the case he is of no use whatever. Unless the leadsman is well trained and attended to, the soundings cannot be worth much, especially when the ship is going fast. Then as to speed, we know that every ship has a particular speed at which she turns better than any other: no two ships agree exactly in this respect. If you determine the velocity with which a vessel will turn at different speeds, you can then calculate the velocity at which she will clear an object at the shortest possible distance, this can easily be determined (see note), and therefore when you say you will slow down the engines or go at a great speed, all depends on the ship herself, and every Officer when he commands a ship ought for himself on the very first opportunity to try her rate of turning at different speeds, and to know all about her movements; by which means he will find out what her safest speed in a fog will be. This is a maximum and minimum question which any one can calculate with the proper data.[1]

[1] To determine practically the speed at which a vessel ought to go in a fog, which is also her best speed for manœuvring, proceed as follows:—

Captain CURTIS: May I add that in carrying a sounding across a bay I think the machine is invaluable, because there is always an indraught of the current, and many vessels are lost thereby, not allowing for the indraught.[2]

The CHAIRMAN: I did not interrupt my friend Admiral Selwyn when he alluded to Sir William Siemens's machine for ascertaining the depth of the sea, because it

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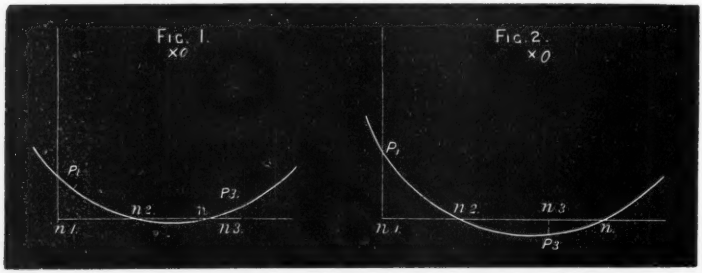
Moor a boat securely in a convenient position, step her mast, and on it fix two distinct well defined marks, one at the mast-head, and the other near her gunwale, so that the vertical distance between them may be 31 feet 5 inches, when the angle between these two marks is 3°; the observer will be one cable's length from the boat's mast, or nearly so. Suppose the vessel running straight for the boat at one cable's length distance from her has the helm placed hard over, and will be certain to run well clear of the boat, in such a case 3° may be adopted as the starting angle, otherwise a smaller angle must be used.

The observer, sextant in hand, should stand on the starboard side of the bridge when starboard helm is to be used, and on the port side of the bridge when the vessel is to be turned under port helm; a cable's length being the adopted distance he sets the index of the sextant to 3°; let the number of revolutions of the engines selected for the first trial be n_1, that for the second n_2, and that for the third n_3, where $n_1 - n_2 = n_2 - n_3$. The vessel must be taken a sufficient distance from the boat to acquire her normal speed for n revolutions before arriving at a cable's length distance from her, and steered straight for the boat. When the reflected image of the upper mark touches the lower mark seen directly, the observer orders the helm "hard a starboard," or "hard a port," as the case may be; when the boat is exactly a-beam of the vessel, the observer measures the angle between the two marks, and notes the reading of his sextant. Similar observations must be made with the engines going n_2 and n_3 revolutions respectively. Let A_1, A_2 and A_3 be the three readings of the sextant corresponding to the respective beam angles; let $A_1 - A_2 = a$,



and $A_3 - A_2 = b$, where a and b are expressed in degrees. With a ruling pencil, a 6-inch protractor, and a pair of dividers, draw the straight line $n_1\ n_2\ n_3$ (Figs. 1 and 2) make $n_1\ n_2 = 1$ inch, and $n_1\ n_3 = 2$ inches; from the points n_1 and n_3 draw the straight lines $n_1\ P_1$ and $n_1\ P_3$ perpendicular to $n_1\ n_2\ n_3$, and taking an inch to a degree, make $n_1\ P_1 = a$, and $n_3\ P_3 = b$ (in Fig. 1, a and b have the same, and in Fig. 2 unlike signs). Through the three points P_1, n_2 and P_1 describe a circle, of which O the centre has been found in the usual way, cutting the straight line $n_1\ n_2\ n_3$ (produced if necessary as in Fig. 2) in the point n; then if n be the number of revolutions of the engine corresponding to the point n, the number of revolutions they should be made to go in a fog, &c., will be given by $\frac{n_2 + n}{2}$. In the cases represented in Fig. 2, it will be better to make another trial with the engines going n_4 revolutions per minute where $n_4 = n_2 - n_3$, and proceed in a similar manner with the three observations corresponding to n_2, n_3 and n_4 revolutions.

[2] The binnacle compass in the gunboat was placed with lubber's point one half a point out from the fore and aft line.

was incidental to this discussion, and likewise because it is really one of the most remarkable instruments that I think was ever invented. Sir William Siemens was good enough to send me his pamphlet, and I remember asking him as to the limits within which he could ascertain the depth of the sea by it, and my recollection of his answer is that he did not arrive at the nice accuracy mentioned by Admiral Selwyn, namely, one-tenth of the depth of water. In 30 fathoms, for instance, the limit of error would only be 3 fathoms. I cannot help thinking—perhaps it was in the earlier stages of his trials of the instrument—that his limits of error were much wider than that. However, we are not here to discuss its merits; as a philosophical instrument it was a very remarkable one. I think we have only now to give our thanks both to Captain Long, for reading the paper, and especially to Captain Buckle for this information. It is most valuable to find a man who has really tried an instrument of this kind, and who can lay before us and before our members and the public generally the real facts of what has happened when the instrument itself has been actually tried, which is of course much more valuable than any discussion even in this theatre.

Captain LONG: I am sorry Captain Buckle is not here to answer for himself, as I know he would have been able, as to the tests he has applied to this machine. He told me once in conversation that he had tried it when he knew what the depth was, and had always found it to be correct. I myself had the other instrument, the depth gauge. I tried that on a great many occasions. Whenever we knew the position at noon when we were in soundings, I used to have a cast taken just on the stroke of the bell so as to be able to see what it gave, and I always found it correct, and had the greatest confidence in it. I think one of the most important things to remark about is that if anybody wants to use it in thick weather they must use it when they know where they are, so as to get confidence in it. I feel full confidence in it myself. I lost mine from using it with the patent log over. That is a thing that ought to be registered for anybody's information, because sometimes navigating Officers do not like to haul in the patent log; and if you put this over when the log is also over, and the vessel is going fast, it is very apt to get wound up, and then the wire breaks.[1]

[Mr. Ludwig Benjamin then exhibited his apparatus for indicating the centre of gravity of loaded vessels.[2]]

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[1] I have since ascertained, in reply to Admiral Boys, that ninety machines have been supplied to H.M.'s Navy to 24th June.—S. L.

[2] See Journal, No. CXXVI.

Wednesday, June 25, 1884.

LIEUTENANT-GENERAL SIR ARTHUR J. HERBERT, K.C.B., Quartermaster-General, Member of Council, in the Chair.

SOLDIERS' FOOD.

By Lieutenant-Colonel TULLOCH, C.B., the Welsh Regiment.

Soldiers' Food in Former Times.

ALTHOUGH the English forces some three or four hundred years ago, when on active service, are stated to have been well fed, each man receiving 2 lbs. meat, 1 lb. bread, and 1 pint of red wine, the standing armies of more modern times when in garrison were very differently rationed. The old saying, "A mere matter of form, like a soldier's breakfast," was probably only too true, and as for his tea, it was not even a matter of form, for it had no existence even in theory; the evening meal not having been instituted till about half a century ago.

The cooking arrangements were extremely primitive, and had but one redeeming feature, viz., extreme simplicity; for the only way in which the meat was prepared for the soldier's dinner was by boiling, when meat and soup were served together, an excellent method in certain cases for getting full value out of the rations, but one which from its monotony must in time have become almost repulsive, and in all probability was often the cause of men taking to drink.

That insufficient and improperly cooked food was in former times one of the causes which produced the high rate of mortality amongst soldiers, no one who has read the sanitary reports on the Army can doubt.

With the soldier's rations of the past, however, we have now nothing to do, but like old uniforms and ancient arms, they may be useful to refer to as showing the progress made of late years.

Officers entering the Service now will hardly credit the records which show that little more than half a century ago European soldiers in the West Indies were often fed on salt meat five days in the week, when good fresh meat and vegetables could have been bought for less money. The result was scorbutic dysentery and a death-rate which in the present day would rouse the indignation of the country.

Instead of doing everything possible to keep men alive and well, the reverse seems to have been the case, and with such success was this mismanagement carried out that it was no uncommon thing for regiments in certain tropical stations to lose one-fifth of their number every year.

Even drunkenness was practically taught to recruits on joining by making a dram of spirits part of the ration, and the canteen stood open from early morning for the sale of spirits to all comers.

Under some restrictions the sale of spirits is still unfortunately allowed in canteens in India. Certain plausible reasons well known to all Officers who have served in the country are brought forward in defence of the system; happily for the soldier, the feeling against the sale of spirits is steadily increasing, and unquestionably no Commander-in-Chief in India will confer a greater boon on the Army than he who first is able to prohibit the issue of spirits in barracks. It is said that spirits are still sold in the canteens of some regiments at foreign stations, but it seems hardly possible in the present day with the strict supervision that exists. Naturally men who are not teetotallers like something with a taste in it when quenching their thirst, but that is no reason why it should be fiery arrack or rum.

Whilst on this subject it may be as well to point out it is quite within the bounds of possibility that bad water, and the inclination to mix something with it, may have made men in the tropics take to drink. A pure water supply is quite as important as good food. It may be mentioned that at a large station in India where the writer was quartered in 1858, it was found that the water for the barrack well percolated through a thickly tenanted cemetery, thereby causing great mortality.

Doubtless many Officers will say that the soldier's food and drinking water are special subjects for the consideration of the Sanitary Branch of the Medical Department, but every one who has been on active, or even foreign service, knows well that there are many occasions in which even subalterns must act on their own judgment with reference to simple questions of food and water, and that every Officer should be just as capable of looking after his men's nutriment without the aid of a medical adviser as he ought to be ready to entrench a post without the assistance of an Officer of Engineers.

With that object in view, therefore, the following notes have been put together in the hope that possibly they may be of some use.

Ration Meat.

One of the first duties a subaltern is called upon to perform is to inspect the ration bread and meat. If the rations are supplied direct from Commissariat slaughter-houses and bakeries, the inspection is usually a mere matter of form. But it often happens that local contractors are employed, and in such cases the Officer on duty must bear in mind that human nature is not perfect, and that a contractor is not likely to give an article costing 8*d.* per lb. if he finds that one costing 6*d.* will pass muster.

At home stations, unless a corps happens to be particularly slack, the rations are, as a rule, fairly up to contract, but by no means always so. Abroad, and especially in the tropics, where the standard of honesty is very much lower than in England, and often entirely

unknown, Captains and subalterns on duty cannot be too particular. Butchers at large stations are pretty well informed as to the characters of the different Officers, and will, when careless ones are on duty, send in with the greatest assurance meat which they know would be at once condemned by more zealous Officers.

The most common defect in ration meat is poorness of flesh, and too great a proportion of bone; of this latter there should not be more that 20, or at the very outside, 25 per cent. Good meat has a marbled appearance from the ramifications of little veins of fat across the muscles, the grain should be fine and the colour bright crimson. The marrow should be a light rosy-red, if brownish or with black points putrefaction is said to be commencing. Too much fat is not often a complaint except in the case of mutton, when an excess of fat is practically a reduction of the soldier's rations, it wastes so much in cooking. It would be a reasonable cause for requiring the meat to be changed.

Putrefaction is occasionally, but not often, a cause for rejection. Smell is the quickest guide to anything wrong in this respect. A simple test, when there is a doubt, is to push a clean knife into the flesh up to the hilt. In good meat the resistance is uniform, in meat commencing to putrefy some parts are softer than others; the smell of the knife is also a reliable test. When the meat begins to turn greenish, and the smell is unmistakably disagreeable, there can be no doubt as to the necessity for condemning the meat. If salt provisions be issued, several pieces should be taken at hazard and cut in two; greenish discoloration, bad smell, or an unnatural putty-like softness, will indicate partial putrescence at time of salting, or defective salting; the meat is unfit for issue.

Meat is generally divided into three qualities, as follows: 1st class, ox or heifer beef; 2nd class, cow-beef and old ox-beef: 3rd class, very old cow-beef or bull-beef. Similarly there are three classes of mutton: wether, ewe, and ram; the latter can generally be detected at once by its rank smell. Written descriptions as to the methods for distinguishing the different classes of beef and mutton would not be of much use, half-an-hour's instruction on the premises of a friendly butcher would be of far more practical value.

It is just possible that in the absence of a Supply Department a regimental Officer might have to purchase cattle for his men. In that case he should take care not to buy any but healthy beasts. These are known by a quick bright eye, the mucous membrane of the nose red, moist, and healthy-looking, the tongue not hanging, the respiration easy, the expired air without odour. When sick the coat is rough and staring, the nostrils dry or covered with foam, the respiration difficult and the movements sluggish; all runnings from the nostrils are suspicious.

Bread.

The other portion of the ordinary Government ration, viz., bread, is in such common use that there ought to be no difficulty in

at once detecting anything wrong in its appearance when a loaf is cut across. A yellow tinge indicates old flour or bad yeast; a piece should always be tasted for sourness. Rice is sometimes used as an addition to the flour because it is cheaper; it retains water and makes the bread weigh more.

Alum enables bread to be made from flour which could not otherwise be used, and whitens the bread. A chemical analysis of the suspected bread is necessary for its detection, 3 grains per lb. are said to be frequently added to inferior bread.

Officers inspecting ration bread ought never to neglect to weigh a certain number of loaves, and it may be as well to remember that 24 hours after baking bread will have lost some 4 per cent. of its weight from evaporation.

The Grocery Rations.

As regards the other articles which make up the soldier's food during ordinary barrack life, viz., milk, vegetables, and groceries, the canteen steward and the master cook are generally the only persons who see them on issue. If these two non-commissioned officers do their duty all goes well, but if there should be any understanding between either of them and the contractors, the soldier is supplied with an inferior article or does not get proper weight. The old system of sending the orderly corporal of the company with the grocery book to the local tradesmen had certain well-known defects which as a rule are obviated by purchase through the canteen.

The subaltern on duty visits the kitchens to see they are clean, but something more than this ought to be done by at least the Captain of the week. It is just of as much consequence that the groceries and extra bread, &c., for which the soldier pays 3*d.* and 4*d.* a-day, should be of good quality and quantity as the free ration of bread and meat. Bad groceries, indifferent potatoes, old stringy vegetables, and watered or skim milk will certainly be supplied by contractors unless they are looked after. As for the men coming forward if anything is wrong, there is a stronger professional pride in Thomas Atkins than most people are aware of, he considers it unsoldierlike to make complaints. As a rule something must be very wrong indeed when he ventures to speak out on the subject of his rations.

Officers commanding companies should look after the grocery books more than they usually do. If a pay-sergeant gets into difficulties, the grocery messing is an easy way to put himself straight by charging the men in their accounts full messing, but not crediting it all in the grocery book.

At the monthly inspection of companies' books by the second in command, not only should the grocery books be produced, but a statement should be given by each company, showing the number of Commissariat rations due and the number actually drawn; bread and meat is sometimes lost to a regiment from want of care in this respect.

On the same slip of paper should be shown the cause of the

difference between numbers drawing Commissariat rations and grocery rations, such as married men, sergeants' mess, out of mess by permission, simply the total in each case. Pay-sergeants have quite enough writing to do as it is, but the Return mentioned is decidedly important, and can be given in half-a-dozen lines.

Nutritive Value of Different Foods.

Before leaving this portion of the subject, it may be both interesting and useful to know the nutritive values of different articles of food. Without going deeply into science, it will be necessary to say what food is. This cannot be expressed better than in the words of Professor De Chaumont:—"A food is any substance which can be taken into the body, and applied to use either in building up or repairing the tissues and framework of the body itself or in providing energy and animal heat, or any substance which without performing those functions directly controls, directs, or assists their performance."

Excluding air and water—both of which are essential for nutrition—the body demands four substances, or rather groups of substances, viz., albuminates, fats, carbohydrates, and salts. Speaking generally, the albuminates are required to repair the waste or growth of muscles and tissues; the fats and carbohydrates give heat and energy; the salts are required for digestive purposes and to build up and keep in repair the bones.

Meat is the general source of supply for the albuminates, although some other foods, such as peas and cheese, contain a very large percentage. Bread, flour, potatoes, and such like, give the carbohydrates or starches. Butter, bacon, fat of meat, and even certain vegetables, such as oatmeal and maize, supply a percentage of fat. In India and Africa, ghee and palm-oil are largely used by the natives in their food. De Chaumont says:—"The nutrition of man is best maintained when he is provided with a due admixture of all the four classes of aliment; and not only that, but he is also better off if he has a variety of each class." With reference to the possibility of doing without one or other of the substances, he says:—"Life may be maintained in fair vigour for some time on albuminates alone, but this is done at the expense of the fatty tissues, especially the fat of the body, and the end must soon come. With fat and carbohydrates vigour may also be maintained for some time at the expense of the nitrogenous (muscular) tissues, but the limit is a near one. If the salts are omitted from the food the unfortunate victim becomes listless, weak, and ultimately succumbs."

With the above short explanation of what food is, the following table of the constituents of the different descriptions of food likely to be used by the soldier is now given from Parkes's work on "Hygiene":—

Articles.	In every 100 parts.				
	Water.	Albuminates.	Fats.	Carbohydrates.	Salts.
Meat of the best quality, with little fat like beefsteaks	74·4	20·5	3·5	..	1·6
Uncooked meat of the kind supplied to soldiers, beef and mutton. Bone constitutes $\frac{1}{5}$th of the soldier's allowance	75	15	8·4	..	1·6
Uncooked meat of fattened cattle—meat very fat	63	14	19	..	3·7
Cooked meat roast, no dripping being lost.					
Boiled assumed to the same	54	27·6	15·45	..	2·95
Corned beef (Chicago)	40	40	15	..	5
Salt beef	49·1	29·6	·2	..	21·1
„ pork	44·1	26·1	7·0	..	22·8
Fat pork	39·0	9·8	48·9	..	2·3
Dried bacon	15	8·8	73·3	..	2·9
Smoked ham	27·8	24	36·5	..	10·1
Horse flesh	74·3	21·7	2·6	..	1
White fish	78	18·1	2·9	..	1
Poultry	74	21	3·8	..	1·2
Bread, white wheaten of average quality	40	8	1·5	49·2	1·3
Wheat flour of average quality	15	11	2	70·3	1·7
Biscuit	8	15·6	1·3	73·4	1·7
Rice	10	5	8	83·2	·5
Oatmeal	15	12·6	5·6	63	3
Maize	13·5	10	6·7	64·5	1·4
Maccaroni	13·1	9	·3	76·8	·8
Millet	12·3	11·3	3·6	67·3	2·3
Arrowroot	15·4	·8	..	83·3	·27
Peas (dry)	15	22	2	53	2·4
Potatoes	74	2	·16	21	1
Carrots	85	1·6	·25	8·4	1
Cabbage	91	1·8	·5	5·8	·7
Butter	6	·3	91		
Egg (10 per cent. must be deducted for shell from weight of egg)	73·5	13·5	11·6	..	·1
Cheese	36·8	33·5	24·3	..	5·4
Milk	86·8	4	3·7	4·8	·7
Cream	66	2·7	26·7	2·8	1·8
Skimmed milk	88	4	1·8	5·4	·8
Sugar	3	..	..	96·5	·5
Pemmican	7·2	35·4	55·2	..	1·8[1]
Pure cocoa kernel	10	20	52	10	·4
Cocoa (ordinary) at 8*d.* per lb.	10	8	23	55	·2
Onions.[2]					
Treacle[3]	23	..	..	75	
Raisins					

[1] Cellulose and theobromine.

[2] Same as cabbage, the difference being chiefly in a very small amount of flavouring oil containing a large proportion of sulphur (sulphide of allyl).

[3] A small quantity of flavouring and colouring matter, and a little acid.

"All cocoa is adulterated more or less, and that sold at 6*d.* or 8*d.* must necessarily be so. The amount of adulteration varies, but the common kinds have about 52 parts of starch and sugar to 48 of cocoa.

"Navy cocoa is also largely mixed with starch, the idea being that this makes it more soluble than pure cocoa; that is, however, a mistake, both ought to be boiled to be digestible. The tinned preparation may be taken as being equal to the ordinary one, according to the proportions directed: that is, a cup or pint of cocoa made from it will be pretty nearly the same as a similar quantity made in the ordinary way with milk and sugar added. I may mention that the Society of Public Analysts make 20 per cent. of fat the limit below which cocoa ought not to be passed, but this gives a wide range from 52 down to 20."—De Chaumont.

Amount of Food Necessary.

The next question which naturally presents itself is, what amount of the four substances named is necessary for a man?

Eliminating the water contained in the food, which would be about 60 per cent. of the total weight, the standard diet for average work is generally accepted as the following—

Albuminates	4·6
Fats	3·0
Carbohydrates	14·3
Salts	1·1
Total	23·0 ozs., water-free.

This argues about $3\frac{1}{2}$ lbs. of ordinary so-called solid food.

Now, an average day's work is represented by a walk of 16 to 18 miles on level ground, the man weighing 10 st. 10 lbs., and his clothes 10 lbs. Of course, if the weight of the man's body to be moved along the road is less than the weight stated, he will not, as in the case of a locomotive, require to burn so much food fuel to do the work. In a state of rest—that is, not absolute repose, but using no active exertion—16 ozs. of water-free food are required, representing about $2\frac{1}{2}$ lbs. of ordinary food. On the other hand, if more than an average amount of work is required, the feeding must be in proportion, or the body suffers, and finally gives way.

The ration during active service is consequently greater than when living quietly in barracks. Lord Wolseley's "Soldier's Pocket-Book" gives the ration in several of the late campaigns, and Parkes gives those of Continental armies when on active service. He suggests the following as a liberal and varied war ration for British troops:—Bread $1\frac{1}{4}$ lb., fresh meat $1\frac{1}{4}$ lb., peas or beans 3 ozs., potatoes and green vegetables 1 lb., cheese 2 ozs., sugar 2 ozs., salt $\frac{1}{2}$ oz., pepper $\frac{1}{20}$ oz., ground coffee 1 oz., tea $\frac{1}{2}$ oz., red wine $\frac{1}{2}$ pint or beer 1 pint. By the table already given the nutritive value would seem to be as follows:—Albuminates 5·75, fats 2·20, carbohydrates 15·76, salts

1·31. Such feeding might be possible with a small force and a perfect system of transport, but a Commissary-General who anywhere but in India could so supply a large army on the move would deserve a peerage.

Nutritive Value of Soldier's Ration.

But to return to a more matter-of-fact subject, viz., the ration in time of peace; its nutritive value is as follows:—

Articles.	Quantity taken daily in ozs. and tenths of oz.	Water.	Albuminates.	Fats.	Carbohydrates.	Salts.	Total water-free food.
Meat	12 ozs., of which ½ is bone.	7·20	1·44	·18	..	·15	2·40
Bread	24 ozs.	9·60	1·92	·36	11·81	·31	14·40
Potatoes	16 „	11·84	·32	·02	3·36	·02	3·72
Other vegetables (taken as cabbage)	8 „	7·28	·14	·04	·46	·06	·70
Milk (⅓ pint)	3·25 ozs.	2·82	·13	·12	·16	·02	·43
Sugar.....	1·33 „	·04	..	..	1·29	..	·29
Salt	·25 „	..	..	..	..	·25	·25
Coffee	·33 „						
Tea	·16 „						
Total quantity ..	65·32 „	38·78	3·95	1·35	17·08	·81	23·19

It may be hardly necessary to state that the 12 ozs. of meat and 16 ozs. of bread are given free of charge; the soldier pays for the remainder, which, at present prices, when the messing is properly looked after, would cost him 3*d.* per day. Abroad the meat ration is increased to 16 ozs. The meat is supposed not to be so good as at home; but, except at Gibraltar, when, during a certain time of the year, Moorish beasts are bought by the Commissariat instead of Spanish, the ration in the Colonies is generally equal to ordinary second-class meat at home. Comparing the above scale with the standard diet previously referred to, it would at first seem that the soldier is well fed, inasmuch as his total water-free food weighs more than the standard diet. On investigation it will be seen, however, that this is caused by an excess of carbohydrates, and unfortunately an excess in one kind of nutriment required by the body will not make up for the deficiencies in another, any more that a deficiency in boots could be made good by a second pair of trousers.

Now, for a soldier who has done growing, and who has not more than an hour's parade a-day, with, say, one guard a-week, the ordinary ration, with perhaps an ounce of butter for breakfast, is sufficient. But it is very different with the recruits of whom the

home army is mainly composed. These recruits, be it remembered, are at instruction drill the greater portion of the day, doing a good average day's work, and requiring a full standard diet to meet it. Nearly the whole of them are also growing lads, and at a time of life when the body requires special sustenance for its development.

In former days, when the recruits formed but a small percentage of the total strength, and when every regiment had several old soldiers with digestive powers impaired by tropical service or other causes, there was generally sufficient spare bread and potatoes for the hungry lads, to whom 6 ozs. of meat is but a mouthful, for it is reduced to that by 20 per cent. of bone and 30 per cent. loss on cooking. But this surplus of carbohydrates wherewith to fill empty stomachs no longer exists, and the recruit's pay has to supplement the deficiency in his rations. In many regiments he is given every facility for spending his money to the greatest advantage, but, unfortunately, in some corps he finds canteen beer the most simple way of appeasing hunger.

Cases have also occurred where the daily mess money has been as low as 2½*d.*; with this sum at home stations, proper nourishment is impossible, and it is difficult to understand how par. 168, Sec. VII, Queen's Regulations, with reference to an evening meal, can have been complied with. Tobacco-chewing, which is said to deaden hunger, and which has become very prevalent amongst recruits, seems to show that there is something wrong.

Every Commanding Officer knows that, on joining, recruits have not that partiality for beer or any other drink which so many fine old soldiers suffered from, and that if they have no temptation to begin visiting the canteen they will maintain their ordinary sober habits; it therefore seems only natural that as they form such a large proportion of the force at home special arrangements should be made for their or rather their country's benefit.

Now that we are obliged to enlist such numbers of youthful recruits it is possible we might take a hint from the Navy, who are so successful with their boys. These, on entering the training-ships, are probably on the average not more than eighteen months or two years younger than the greater proportion of army recruits.

The young fellows are kept on board the training-ships for about two years, and during that time receive the following rations:—

Sailor Boys' Rations.

Soft bread daily	1½ lb.
Sugar	1½ ozs.
Chocolate	¾ ,,
Tea	⅛ ,,
Fresh meat six days in each week	¾ lb.
Seventh day corned pork	1 ,,
Mixed vegetables two days in each week	½ ,,
Potatoes or other vegetable according to the season daily	¾ ,,
Flour two days in each week	½ ,,
,, ,, ,,	¼ ,,
Fresh suet two days in each week	1 oz.

Fresh suet two days in each week	½ oz.
Raisins two days in each week	2 „
Split peas one day in each week	4 „
Treacle daily	2 „

Celery seed, mustard, pepper, vinegar, and salt a sufficient quantity.

In addition to the above there is issued daily for each boy's breakfast corned pork 4 ozs.

On leaving the training-ship the lads are as powerful a lot of young fellows as one would wish to see.

Of course it could hardly be expected that the Army Estimates would stand the addition which such feeding would demand, but still something might be done by giving to extra food the amount saved on deserters and other non-effective pay and rations, all of which have been credited in the annual vote.

One penny per day added to the present messing money of the infantry at home—about 50,000—so as to bring the daily amount to be expended up to 4*d.* or 4½*d.*, would give almost sufficient nutriment, and would only cost about 75,000*l.* per annum.

Any proposal to increase the food of even the recruits of the English Army, would be certain, however, to be met by the old and somewhat incorrect assertion that our soldiers are, as it is, very much better fed than the men in other armies. It may be as well, therefore, to know what their food amounts to in nutritive value.

Rations of Foreign Armies.

The French soldier's ration in time of peace is as follows :—

Munition bread	26·4	ozs.
White bread for soup	8·8	„
Meat	10·6	„
Vegetables (green)	3·5	„
„ (dried) principally haricot beans	1·1	„
Salt	·5	„
Pepper	·73	„
	51	„

This gives—

Albuminates	4·33	ozs.
Fats	1·25	„
Carbohydrates	18·04	„
Salts	1·04	„
	24·74	ozs. water-free food.

In war the principal change is an increase of biscuit for bread, with beans instead of green vegetables, half-pint red wine or about one-tenth pint of brandy is sometimes given in place of coffee and sugar.

The Prussian soldier in barracks receives—

Bread	26	ozs.
Meat	6	„
Rice, or	3·20	„

Groats, or	4·21 ozs.
Peas or beans, or	8·22 „
Potatoes	53·08 „
Salt	·87 „
Coffee	·468 „

This gives about—

Albuminates	4·8 „
Fats	1·1 „
Carbohydrates	17·4 „
Salts	1·5 „
	24·80 ozs.

In time of war the ration is largely increased, and special issues are issued as required. It may be interesting to Officers to know the composition of the celebrated pea-sausage ("Erbswurst"). De Chaumont's analysis is as follows:—

Water	5·830 per cent.
Fats	35·616 „
Albuminates	15·342 „
Carbohydrates	37·402 „
Salts	5·810 „
	100·000 „

An ounce gross weight would contain—

Fats	·356 oz.
Albuminates	·153 „
Carbohydrates	·374 „
Salts	·058 „

The taste is like that of cold pease-pudding with the addition of fat, boiled for a short time with water; it makes a very palatable soup. When used too frequently the men disliked it, and it produced dyspepsia.

The Austrian Soldier

in time of peace receives, bread, 31 ozs.; meat, without bone, 6·6; suet, 0·6; flour (or vegetables in lieu), 2·5; salt, 0·6. To this are added a little garlic, onions and vinegar. These give about—albuminates, 3·7; fats, 1·6; carbohydrates, 17; salts, 1; total water-free, 23·3. In time of war the nutritive value of the regulation ration is as follows—albuminates, 4·5; fats, 3·2; carbohydrates, 22·8; salts, 1; total water-free, 31·5.

Russian Soldier.

There are 196 meat days and 169 fast days in the year. On the meat days meat is given with cabbage-soup and buckwheat gruel. On the fast days the meat is replaced by peas, and occasionally fish. 42 ozs. of rye bread are issued daily.

The nutritive value is as follows:—

Albuminates, 5·8; fats, 1; carbohydrates, 25; salts, 2·5; water-free food, 34·30. On the march $1\frac{3}{4}$ lb. biscuit is issued instead of bread. On very rare occasions $\frac{1}{4}$ pint of brandy is added.

	Albuminates.	Fats.	Carbohydrates.	Salts.	Total water-free food.
Russian	5·8	1	25	2·5	34·30
Prussian	4·8	1·1	17·4	1·5	24·80
French	4·33	1·25	18·04	1·12	24·14
Austrian	3·7	1·6	17	1	23·30
English	3·95	1·35	17·08	·81	23·19

Indian Army.

Many of the native troops in India, who are fine strong men and good fighting material, never touch meat, but the actual amount of albuminates, fats, carbohydrates, and salts in their food often exceeds, and is really a more nourishing diet than that of the meat-eating European soldier, but that the stomach of the flesh-eating Englishman could without training digest the bulky and peculiar food of the natives of tropical countries is doubtful. On the other hand, till lately, many soldiers before enlisting hardly knew what meat was. Oatmeal and peas bannocks in Scotland, and potatoes in Ireland, composed nearly the whole of their diet, but the amount of the last-named vegetable which had to be eaten at each meal to give the requisite nourishment was immense. Oatmeal porridge is still extensively used by all classes in Scotland, and, considering its nutritive value and cheapness, it seems a pity it is not a recognized article of soldier's diet at home.

The foregoing statements regarding the food of other armies will show that we do not stand high in the scale of nutriment, whereas for the present home army, at least, we ought to be at the top of the list, instead of the bottom. For this reason: on the Continent where conscription makes the supply unlimited, the recruits are twenty years of age on joining, and have nearly done growing. With us the majority of recruits are growing lads, many of them unquestionably under eighteen years of age, whose bodies demand special feeding to meet the requirements of average work and growth at the same time.

The scale of diet amongst the labouring classes is gradually improving, and before long it will be necessary to make corresponding advances in that of the soldier on home service; that is if we wish to get recruits of proper physique, or to give Nature a chance of turning growing lads into strong men.

The increase of $\frac{1}{4}$ lb. to bring the meat ration at home up to what

it is abroad has been proposed, but that would add a quarter of a million annually to the Estimates, a sum which just now is not likely to be granted.

Suggestions for Improving Present Existing Rations.

But happen what may hereafter: in the meantime it is the duty of regimental Officers to do the best they can, and to see that the present Government ration is used to the greatest advantage, and that the young soldiers are afforded every facility for spending their pay on extra food as economically as possible. Officers do not, as a rule, think much about cooking, but those who do, know that the establishment of the Instructional School at Aldershot was one of the greatest boons ever conferred on the soldier. Fortunate is the regiment which has a really good zealous master cook.

In one regiment which possesses such a man, and possibly in other corps also, an excellent method of getting full value out of the meat ration has been adopted. Immediately after the dinners, all large bones are collected by the orderly men and taken to the cook-house, where they are boiled for seven or eight hours next day. It is found that 30 lbs. of good-sized bones—the largest being crushed—will, with 8 lbs. vegetables, 8 lbs. split peas, and 4 lbs. flour, give upwards of 100 pints of good soup, at a total cost of 2*s.* 6*d.*[1] The sale of the refuse can generally be made to cover the cost of vegetables and flour, and the recruit by going to the cook-house between certain hours in the evening gets a basin of soup for nothing; this, with a piece of bread, is almost a meal in itself. There is a greater demand for soup in the winter than during the summer, and the numbers coming to the kitchen vary in direct proportion according to the amount of money the recruit has in his pocket: on pay-day hardly any come; the following day the number increases, and on the evening before pay-day, there are rather more applicants than can be supplied with soup.

As regards the refuse, few Officers know its value, and those who arrange for its disposal are generally well satisfied if they get ten or twelve shillings per 100 men per month for it. The people who purchase refuse dispose of it as follows: the bones go to the manure manufacturers, who give ½*d.* per lb.; the fatty refuse to the tallow-chandlers, who give 3*d.* to 4*d.* per lb.; and the potato parings, vegetable refuse, scraps of bread and such like, to people who keep pigs.

Now, 100 men receive daily in their rations 15 lbs. of bone, that in value amounts to 7½*d.*; and at least 1 lb. of fatty matter may be looked for, that is 3*d.* per day; and the remaining daily vegetable refuse per 100 men has been stated by those who have bought it for years as being equal to the keep of two pigs, that is to say 1*s.* per

[1] The bones lose or rather give as stock one-third of their weight in eight hours' boiling. During the winter unused stock or soup can be kept for three or four days, to meet the extra demand for soup just before pay-days.

day. Total per day, 100 men 1*s.* 10½*d.*, that per month of thirty days is 2*l.* 16*s.* 3*d.* Of course, a great deal depends on the way in which the refuse is collected; there is probably considerable waste, but even with a good margin in this respect, and for the labour in collecting, the purchasers of refuse do not make a bad business of it.

At large stations, unless some kind of ring has been established amongst the humbler parasites who live on the soldier, good prices ought always to be got for refuse; but at small stations the regiment is practically at the mercy of perhaps the only person who for years has attended the barracks.

Another way of causing the men to be better fed is by establishing a system whereby any man who wants extra messing, such as plum duff, rice pudding, and such like, can get it by giving his name to the orderly corporal, and paying at the end of the week.

The master cook simply gets the number of different kinds of puddings or pies each company requires, and indents on the canteen for the materials by companies. At the end of the week, the money is deducted at the pay-table, and the canteen account settled at once. Each company has what is called a pudding-book, the keeping of which gives little or no trouble, and the system works without the slightest hitch, although sometimes 300 out of 400 in mess have puddings. The company cooks do not at first care to do the extra work without some remuneration, but when it is pointed out that it is part of their duty, objection at once ceases. Occasionally, it may happen that with men who do not understand how to economize fuel there would be difficulty in getting enough coal for boiling the bones, but a proper master cook will soon put that right.

The puddings which are most in favour are composed as follows:—

1 lb. flour, costing	1¾*d.*
¼ lb. raisins „	1¼*d.*
¼ lb. currants „	1*d.*
¼ lb. suet from the rations.	

This gives a little over 2 lbs. of what is known as plum duff; sufficient for four men, costing them 1*d.* each. Two men generally share a rice pudding; its composition and cost are as follows:—

½ lb. rice, costing	½*d.*	Weight nearly 2½ lbs.
1 pint of milk.....	1½*d.*	
4 ozs. sugar.....	1*d.*	
Total.....	3*d.*	

The ordinary delf or block tin basins are used for cooking the puddings; men are also allowed to bring their own flour and fruit, such as apples and blackberries, to the cook-house to be made into pies. In former days, before the establishment of the school of cookery, the cooks used to consider that they had a right to appropriate about half of any extra food brought to the cook-house for their trouble in preparing it. That now is quite a relic of the past.

Although it is unnecessary for Officers to know much about regular cooking, such as would be carried on in a barrack kitchen where there is always a master cook to superintend, it would be most advisable that they should get as much information as possible about field cooking, and that they should be taught practically how to tell good from bad or indifferent meat, and that the various substitutes for potatoes and our ordinary English greens which are to be found in foreign markets should be brought to their notice as well as those wild vegetables which occasionally are so useful on a campaign.

The instructional establishment at Aldershot would seem to be the proper place to learn what is required, and when Officers happen to be at that station, they could easily spare a week's attendance, which would probably be sufficient for the purpose named.

The Regimental Canteen.

The next establishment to be considered is the canteen, and fortunate is the regiment which has a perfect steward. So many temptations are thrust upon canteen keepers, that it is no wonder if some try to make money. Brewers are said to be rather heavy payers of black-mail, and with the best intentions they are often obliged to succumb to commission; but on the other hand there is great competition for the supply of canteens, and so high does it run, that attempts have even been made to bribe Commanding Officers with whom rests the selection of the brewer.

That the brewers are often forced to arrange matters with the canteen steward, the following will show :—A Commanding Officer agreed to give the canteen supply to a brewer on the condition that the steward should not receive commission on sale of liquor, and that the men instead should get the full value of everything. The brewer said he would do what was required, but told the Commanding Officer it would not be long before his beer would be complained about. As predicted, the men in due time stated the beer was undrinkable. It had simply been damaged on purpose by the canteen keeper to get a brewer employed from whom he could obtain the expected black-mail.

Another way in which certain canteen stewards add to their income is by getting and selling on their own accounts articles on which there is a good profit, without passing them through the canteen books at all.

If groceries are got through ordinary dealers there is always danger of commission; the best plan is to get everything possible from the Stores, but there have not been wanting instances of audacious stewards who found that articles from the Stores, like the beer which paid no commission, were bad.

Joint or garrison canteens are objectionable, if bar fittings cannot be found for all the corps in garrison, yet each regiment ought to be allowed to have its own provision shop.

When making contracts for vegetables care should be taken that

the contracts are not for too long a period (say not more than three months), thereby tying a regiment down to a particular person and preventing their getting the advantage of a fall in prices; the regular contractor will take very good care of himself in this respect.

The prices paid by regiments are in some cases absurd, such as 8*d.* and 10*d.* per stone for potatoes, when the wholesale prices in the nearest large market, where the canteen should buy, are perhaps half the sum named. It is at times the same with regard to the prices of butter, bacon, and eggs, all of which are bought by the soldier at the canteen.

Recreation-room Bar.

The recreation-room bar is also made use of for light refreshments, such as coffee, biscuits and cheese, bread, pickled fish, and pigs' feet. At early morning parade the recreation-room does a good business if the sergeant in charge has a barrow on the ground. A large cup of coffee, with milk and sugar, can be given for ½*d.*

Barrack Rooms.

The only other subject with reference to soldiers' food in barracks is the place in which they eat it, viz., their barrack rooms. It is quite time that a little more civilization should be apparent in the necessaries for a soldier's dinner-table, such as receptacles for salt and mustard, with possibly galvanized iron dishes and large basins for meat and soup. Every man should have a horn or metal drinking cup, and possibly as a hint it may be mentioned that a tin cover to the pail in which the tea is brought from the cook-house is better than nothing, or even than a dirty cloth. Cooks sometimes think they can get the most out of tea by boiling it, whereas by putting the tea in a tin pail, pouring the boiling water in and putting a proper lid on, not only is the tea hot when it gets to the barrack room, but it is properly made and not bitter.

Boiling tea on board ships is a common mistake, and in hired ships it has been done to give a false strength of colour; a portion of what should have been used having been kept back and sold by the ship's steward.

Receptacles in the barrack room for the day's bread and anything saved for tea are much wanted. As it is, provisions, cleaning rags, and such like, are all placed on the hanging-shelf, exposed to the deposit of pipeclay and thick dust of the room. A closed shelf might easily be made under the hanging one, where plates and provisions could be stored. The estimated cost is 6*d.* per man. If done gradually the canteen funds of regiments would cover the expense.

Every regiment ought to have some proper contrivance for carrying the men's dinners hot to the guard room instead of making an orderly parade with each man's canteen full of soup or stew; by the time he has answered his name, marched off, and reached the guard room, the dinner is an unpalatable half-congealed mass.

Food on Troop-ships.

In the natural course of events the food on board the troop-ships is the next consideration, and it may be as well to note for general information that every man on leaving barracks for embarkation ought to have a pound of bread and half a pound of cheese in his havresack, no matter how short the railway journey may be, or whether the men are to be rationed on board the same day or not.

Baggage fatigues on the jetty and the little difficulties in getting the messes into working order the first day with men who probably have never been on board a ship before, make it advisable that men should not be dependent on regular meals the day of embarkation.

As regards the food supplied on board, although the men dislike soup and bouilli days, it is ample, and the recruits get fat. Many Officers are of opinion that when in the tropics some other drink should be given in place of the heavy sleep-producing porter. If cheap red wine, such as the French use all over the world, could be given instead, it would doubtless be an improvement.

In the case of convalescents and children returning from India, Officers can be of great use if they will do something more than walk rapidly round the decks with the regulation cry "Any complaints?"

On one ship which came to Portsmouth, the duty-doing convalescents who could not masticate the salt meat were indebted to the naval Chaplain for finding out what was wrong, and getting them properly fed. In another case the children, some 300 or 400 in number, were in such a state of debility when they landed that on being attacked by measles they died at such a rate as to cause much indignation; doubtless the carelessness and ignorance of their mothers, who had had everything done for them in India, had something to say to it. The poor little things did not die in vain, for on the matter being represented to the Admiralty an order was given that women and children should have bread every day instead of biscuit on three days of the week. It was all very well casting the blame on the Medical Officer in charge, but he might possibly never have done duty in a trooper before, and be ignorant that he had only to ask for anything in the ship to get it.

For the benefit of invalids it would be very advisable to have selected Medical Officers attached to troop-ships for the season, but be that as it may, no duty-doing Officer in the ship referred to was, I venture to consider, quite free from blame, and it may be suggested that time spent in looking after the comforts of invalids, women, and children in ships returning to England would for many be a welcome change from the monotony of lounging about on the poop all day.

Food on Active Service.

The feeding of men on active service is of course the most important of all. Some regiments will manage to keep well and send few men to the hospital, whilst others, precisely similarly situated, who are not

properly looked after, suffer greatly. Instead of using strong language about the Commissariat, who are often struggling against difficulties of which few but the General Staff have any idea, Officers might often manage so as to add to the soldier's rations. For instance, on arriving in a deserted village a pile of millet or Indian corn might be discovered; now, where there is hard grain grinding apparatus of some kind is generally to be found, and a supply of good damper cakes might be served out. Such a case came under the writer's notice in the last China Campaign. A supply of flour was obtained in a village by a regiment at the end of its march; the bakers in the ranks were at once summoned, some kind of oven was found or extemporized, and next morning, before marching off, some very much more palatable stuff than biscuit was in every man's havresack. At first there was a difficulty about a trough to mix the dough, but a quick-witted fellow managed to find a huge and perfectly new Chinese coffin which answered admirably. If the natives are at all friendly, kind treatment and English sovereigns or dollars will, as a rule, work wonders, and produce not only bread and vegetables, but cattle and sheep, where such productions would seem impossible.

Every regiment ought to have an interpreter and a supply of printed proclamations. Fear of our doing them personal injury is what keeps the villagers away. Each brigade ought to have attached to it the moment it goes on service a party of fifteen or twenty *mounted* military police under an Officer to prevent plunder. The damage done to an army, and especially to the advanced part of it, by the plundering of independent camp-followers, and the thoughtlessness of parties sent out, say, to obtain green forage, or, perhaps, firewood, who take the first that comes to hand, possibly agricultural implements of great value to an unfortunate peasant, is inconceivable; and not content with taking everything they can move, camp-followers seem to delight in doing as much mischief as possible; breaking and even burning what they cannot carry off. To attempt to keep such individuals in order by any other punishment than flogging is a farce. The example of immunity from punishment is most pernicious to our own men. First the scamps of a regiment do what they can to follow in the steps of the camp-followers, and if they escape detection and sharp punishment, others follow their example, till at last soldiers consider that the curse bequeathed to the army by the Mutiny Campaigns, viz., looting, is a right.

With every respect for those magnificent soldiers, our Indian cavalry, I venture to think that the looting propensities of their followers, for whom nothing is too hot nor heavy, must ever prevent that force being employed in Europe, where so many first-rate Officers would lead them with the utmost confidence against anything. However willing civilized European peasants might be to help us, the plundering and mischief of the native followers would turn every one against us.

As regards the food now generally supplied on active service, viz., tinned, instead of salt meat, improvement is possible in its prepara-

tion. That served out to a certain portion of the force in Egypt seemed very devoid of fat, and after a short time it became nauseous, and one preferred living on cocoa and biscuit. Tinned cocoa and milk (Moore's) of which one never tires, is a most excellent thing in a campaign. It ought to be made part of the ration on field service. With abundance of firewood, as in Canada, plenty of tea and sugar is what is wanted, but in tropical, or even sub-tropical countries, firewood is often the great difficulty.

If hot water cannot be got, cold will dissolve the paste of tinned cocoa and milk.

Spirits on active service are very rarely indeed necessary, but all those who had been living on tinned meat, biscuit, and dirty water for the first week at Kassassine, cannot forget the murmur of approbation that went through the camp when the grog bugle sounded, and a ration of rum was served out to every one. On that occasion there can be no doubt that an issue of rum was beneficial as a stimulant, just as a dose of some particular kind of medicine would have been necessary in other conditions of the body. By regulation, spirits are not now issued except under medical advice; but if our army ever has to campaign in Europe, I venture to think that light red wine might be added to the rations with advantage.

Lastly, as regards the manner of carrying his provisions. The havresack is used by all ranks, and the recent reduction in the size of that article of equipment is a move in the wrong direction. How three days' provisions with the other articles a soldier has to carry are to be put into his havresack is a puzzle. If the button comes off, the man stands a good chance of losing the greater portion of his food, and in the case of a cavalry man, he would be certain to do so with the present shallow havresack. The canteen tins are also now too small; that article is often required on service as a pot to boil water, and ought to have been made deeper instead of shallower.

Difficulty is often found in opening the meat tins properly, and the meat is frequently turned out in a stringy unsightly mass.

Now, in the pioneer's equipment are certain ancient articles called gun-spikes; instead of useless gun-spikes it would be better for them to carry meat tin-openers.

The old flat-sided felling axes of the same equipment ought also to be changed for round-sided ones in common use all over America, and now employed in this country by woodmen.

Note.—Commanding Officers in India, who know the evils caused by allowing raw spirits to be sold in canteens, have tried various substitutes; the most successful seems to be a drink composed of half a dram of rum or arrack in a soda-water bottle of aërated water. As nearly all canteens in India have a soda-water machine there is no difficulty in filling the bottles.

Possibly the first step towards the prohibition of spirits might be most easily made by forbidding the issue of any description, unless mixed with two or three times its bulk of water, like navy grog. But before prohibiting the sale of spirits it will be necessary to find some substitute which will suit the soldier's taste.

The strong country-made ales of India are not liked by everyone, and may be the cause of a certain amount of liver complaints. French wines with body enough for the private soldier would probably be too expensive, but it might be quite worth while for the Indian Government to try the experiment of importing certain cheap Italian and Spanish wines, such as Chianti and Preorata; the latter is well known at Gibraltar; rough Devonshire cider might also be thought of.—A. B. T.

Appendix.

Average Messing of a Regiment stationed at Londonderry, April, 1884.

One company having 48 men in mess. The messing money being 3*d.* per day, sum to be expended 12*s.*

1*st Day, Bake.*

	s.	*d.*
Tea, 1 lb. 4 ozs. at 1*s.* 7*d.*	1	11¾
Sugar, 8 lbs. at 3*d.*	2	0
Flour, 1 lb. at 1¾*d.*	0	1¾
Potatoes, five stone at 3½*d.*	1	5½
Onions, 6 lbs. at 1½*d.*	0	9
Milk, 4 quarts at 3*d.*	1	0
Salt, 2 packets at 1*d.*	0	2
Mustard, 8 ozs. at 7*d.*	0	3½
Pepper, 8 ozs. at 7*d.*	0	3½
Best fresh butter, 3 lbs. at 1*s.* 2*d.*, for breakfast	3	6
	11	7
Credit	0	5
	12	0

2*nd Day, Stew.*

	s.	*d.*
Balance credit brought forward	0	5
No. of men in mess 48 at 3*d.*	12	0
Sum to be expended	12	5

	s.	*d.*
Tea, 1 lb. 4 ozs. at 1*s.* 7*d.*	1	11¾
Sugar, 8 lbs. at 3*d.*	2	0
Flour, 2 lbs. at 1¾*d.*	0	3½
Potatoes, five stone at 3½*d.*	1	5½
Salt, 2 packets at 1*d.*	0	2
Pepper, 8 ozs. at 7*d.*	0	3½
Milk, 4 quarts at 3*d.*	1	0
Mixed vegetables, 8 lbs. at 1*d.*	0	8
Bacon, 6 lbs. at 7*d.*	3	6
	11	4¼
Balance credit	1	0¾
	12	5

3*rd Day, Boil (Pea-Soup).*

	s.	*d.*
Balance credit	1	0¾
48 men in mess at 3*d.*	12	0
	13	0¾

	s.	d.
Tea, 1*s.* 4*d.*	1	11¾
Sugar, 8 lbs. at 3*d.*	2	0
Flour, 2 lbs. at 1¾*d.*	0	3½
Potatoes, five stone at 3½*d.*	1	5½
Mixed vegetables, 10 lbs. at 1*d.*	0	10
Milk, 4 quarts at 3*d.*	1	0
Split peas, 12 lbs. at 2*d.*	2	0
Salt, 2 packets at 1*d.*	0	2
Pepper, 8 ozs. at 7*d.*	0	3½
Extra bread, 24 lbs. at 1½*d.*	3	0
	13	0¼
Balance credit	0	0½
	13	0¾

The days on which extra bread, bacon, and butter were got, was left to the men themselves. As a rule they preferred butter to either bacon or bread, probably because so many had puddings for dinner, and did not then care for bread at that meal. If a little extra bread was required with their evening soup they used to buy it themselves at the recreation bar. Sometimes for a change the whole mess would agree to have puddings instead of either bacon, butter, or extra bread.

Occasionally messes have their rations made into meat pies, but as a rule the men seem to prefer either a bake, a boil (soup), or a stew; the latter is a favourite dish with the recruits.

Owing possibly to the good feeding, and also to the men having less money to spend in the town, the cases of drunkenness during twelve months only averaged 1 per cent. a-week, nearly the whole of those being amongst the older hands.

The various methods of preparing the dinners are all given in the pamphlet, "Instructions to Military Cooks," price 3*d.*, to be bought at W. Clowes and Sons, 13, Charing Cross, or Harrison and Sons, 59, Pall Mall. Every master cook should be obliged to have the book for reference whenever required.

The Report of the Royal Commission on Sanitary State of the Army, Lord Herbert, 1858, gives much information in the Appendix about soldiers' messing.

The CHAIRMAN: Though this is not a very numerous assemblage, I believe that some of the Officers present have taken a great deal of interest in this subject, and would like to offer some observations as to their ideas of messing. There is little doubt that, in the main, Colonel Tulloch is perfectly right, but I think there may be many minor differences that Officers may like to discuss.

Lord WILLIAM SEYMOUR: Might I ask Colonel Tulloch whether he has ever directed his attention to the hours at which our soldiers should receive their meals in peace-time and also on service? Because that, I think, with regard to the new ration which Colonel Tulloch has suggested, would be a very strong point.

Colonel W. W. KNOLLYS (late 93rd Highlanders): I do not rise to express any difference of opinion with what Colonel Tulloch has said. I heartily concur in all his remarks. His lecture has not only given us a great deal of information, but will induce us all to turn the matter over in our minds, and probably thereby, on some future occasion, produce some new ideas on the subject. I have a very strong con-

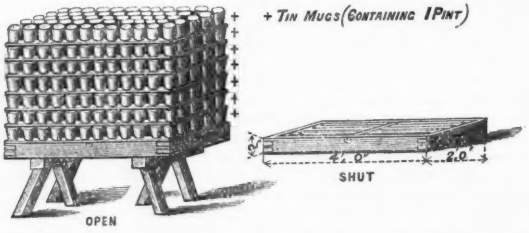
viction with regard to the effect of insufficient rations and food on the behaviour of men, especially with regard to troops. I am quite certain, if the growing lads we have, had as much to eat as they wanted, they would drink very much less; they would smoke very much less strong tobacco, and both beer and tobacco do them a very considerable amount of injury. We have practically the very youngest army in Europe. Not a single foreign soldier actually joins the regiment under an average of about 20½ years, whereas the average age of our men is at least two years younger, if not more; therefore the ration that was found, perhaps, barely sufficient some twenty years ago is certainly very insufficient now. It is true that these young soldiers, after they have been four or five years in the ranks, will want very much less food than they do at first, when they feel a positive craving, and there are now too few old soldiers to supply the deficiency. Another point which arises out of, although it is not actually connected with, the lecture, is the question of the soldier being provided by Government with his messing free. There is an immense amount of discontent among troops on finding that the ration is not sufficient, and that they practically pay nearly half the cost of their food. It is true the expense would be appreciably large, but I cannot but think that it would be greatly compensated for, if not altogether made up, by increased health, by diminished desertion, and diminished crime. Nothing is so costly as crime and disease, and therefore an outlay of money that would diminish either is really true economy.

General McKAY: I have listened to Colonel Tulloch's lecture upon the Food of the Soldier with great interest. I have recently been in command of a brigade depôt, and have had to look after recruits, and in what I am about to say I only judge of this question by results. A recruit, six weeks after he has joined the Army, if there is any care taken of him at all, will be found to be a very much better individual than when he joined us; and if you weigh him three months afterwards, he can scarcely get into his clothes. I think this is a clear proof that if you do not give him too much to do, the food you give him is quite enough for the purpose. I used to question every man whom I passed in the Army as to what had been his food, and I do not suppose that two in ten had more than one meat meal a week. The fact is, I have had many men admitted into hospital because they were too well fed for the first month after joining. I have seen many men admitted to hospital for that reason. I do say that when you compare the ten hours that a man has worked at field labour, or whatever it may be, with the four hours' drill that he gets (and no Commanding Officer can employ him more than that), it is a mistaken cry to say that the recruit has too little food. I know a good deal of the Army; I knew the time when the soldier had only one meal a day, and that was dinner; when he had skilly for his breakfast, and was very thankful to make a supper for himself. Compare him then with what he is now—why, he lives sumptuously. The improvements in our canteen are immense. The coffee-shop attached to the recreation room is in most instances a myth, because the soldier can get all he requires in the canteen. If the canteen is nicely regulated, which I am disposed to believe it is, by most Commanding Officers, there is no risk of the soldier being tempted to take a glass of beer. The great advantage of the recreation room is that he can get a cup of coffee, and in most regiments, I think, that is provided for. There is a point, I think, in regard to the soldier which might be considered for his good, and that is securing good drinking water when on the march. I remember having been called to go to the camp at Delhi with my battalion, and my first thought was, "If I am to be changing my camp every week, how am I to get good water?" I sent for my armourer, and directed him to make two filters on the Macnamara principle. Beer had to be taken for the men, and I decided "where a barrel of beer can be carried, I can hope to take a filter." I took a filter, and all the time I was in that camp, moving from place to place for twenty-three days, wherever my regiment bivouacked, there was the filter for filtering water; I had the pleasure of knowing that my men were well supplied therefrom with clean, wholesome water, which they much appreciated; and at the end of the camp I sold my filter to the Commanding Officer of the 51st, who was going on the march to another station. I think if provision were made for regiments when they go on the march to have a filter with them, a great advantage would be secured. As to the offal we have heard mentioned, we have to thank our present Commander-in-Chief for looking after that. So far back as 1839, I think,

when he commanded the 17th Lancers, His Royal Highness gave the impetus for that wise provision. I must say a regiment is greatly at fault when it is content to sell its offal for 10*s.* or 12*s.* per 100 men. Why, at a little brigade depôt I got 1*l.*, and we took care the bones were well utilized before they went to the offal-tub; so that I think is a mere matter of arrangement. Then with regard to feeding: there is such a document as a messing-book. I insisted upon there being no balance at the end of the week; it was either expended in butter or in making a pudding. But I went even further, I made the non-commissioned officers, as a rule, responsible that all the bread, that used to go to the offal-tub, should be collected, and that was made into a pudding once a week for the men. On the whole, I do think that in peace-time we want no more food for our men; in war I think we do, when the men have to work harder and under exposure. But when you consider that the soldier has only four hours' work as compared with ten hours' hard labour before he joins the Army, I think that our present ration is sufficient for the purpose.

Colonel CLIVE (Grenadier Guards): With reference to what General McKay has just said, I understand that in his opinion (1) the soldier's present ration is sufficient for him in peace times, and (2) the work done by the recruit is not sufficiently severe to make him require more: therefore, on both points he is at issue with Colonel Tulloch. I agree entirely with the lecturer. The point on which I venture to think General McKay is mistaken is that he forgets what poor feeding a recruit comes from. It is perfectly true that our recruits all gain weight on the present ration within the first month or three months after joining, but that fact cannot be taken necessarily to show that the man is getting enough to eat; it merely shows that he has got a great deal more to eat than he got before he joined; and, in fact, if you saw the class of recruits that come into St. George's Barracks or any recruiting depôt, you would say they were the hungriest-looking lot of fellows you had ever seen. I ask them continually "What led you to enlist," and in nine cases out of ten they answer "Want of work." The real truth is they are so ill-fed before they enlist that when they come up and get our rations they improve in condition. But I, nevertheless, consider that they do not get as much as they ought to get. Then, as to the four hours' drill not being sufficient to make a recruit require a larger supply of food, I must say I have seen a recruit perspire when he has been simply standing at attention, owing to the strain put upon a fresh set of muscles. The mere fact of stiffening these muscles and squaring his shoulders has been sufficient to make the perspiration run off him; and with reference to the quality of work, I believe that four hours' drill is quite as much to him as ten hours' work in the fields. Another point on which I agree with Colonel Tulloch is this, that if you gave the men more to eat, you would decrease crime in the Army. I recollect being told by a Officer of Marines at Port Cumberland that he had put a stop to all the insubordination that had previously existed, simply by getting the men to eat something for breakfast. Half the insubordination in the Service is due to men coming in late at night and being turned out early in the morning, perhaps for 5 or 6 o'clock parade, without a meal inside them to put them in good humour. This Officer said the first thing he did was to get in some herrings and eggs, and to send them round to the barrack-rooms every morning, and every man instead of having a piece of dry bread, which he has no appetite to eat, and a cup of bad coffee, made a bit of a breakfast, was in good humour with himself and with his superiors, and then there was no more insubordination. I think if we could manage to make soldiers eat something before they go on parade, and to have their dinner, if possible, when they have done their day's work, we should keep men in barracks more, and do good to the Army. With regard to giving the man something to eat in the field, I should like to mention the plan adopted by the 24th Middlesex (the Post Office) Volunteer Corps. They are a very good volunteer corps, and they have got an excellent system of supplying refreshments for their men during or after a long parade. They have a whole lot of tin cups, enough for one company, filled with beer arranged on a deal slab, and then another slab on the top similarly furnished, and so on with as many tiers as there are companies, so that they get cups for every man in the battalion and all full of beer, and all brought to the ground by the brewer or canteen sergeant. He finds out where they are going to have luncheon, and gets his staging ready and his

cups filled. At the end of the table there is a large box of pork pies, sausage rolls, and any other eatables required, and as soon as the drill is over, the corps piles arms



in quarter column, each company is marched up to the table in file, one rank passes on either side of the table, and each man takes a pork pie in his hand and a cup of beer and returns to his place in column to eat his lunch. When the column moves off the brewer collects his cups and the whole operation is completed in ten minutes. That is a much better plan than wasting half an hour in marching men to the canteen cart.[1]

Dr. de Chaumont: I quite agree with what has been said by Colonel Clive with regard to giving the soldier sufficient food. It is quite true that the amount of drill is not very great, but I think the strain upon the recruit is much greater than appears on the surface. It is one thing to have a certain amount of work to do for a certain number of hours, but it is quite another thing to have that work compressed into a much shorter time; you increase the velocity, and therefore increase the strain. It is well known that in mechanical engines the consumption of fuel varies as the cube of the velocity, and we may apply this rule very much to man, and to what the soldier does. I think if we were to calculate carefully—it would be a very difficult calculation to arrive at from the difficulty of getting all the data—we should find that the results of four hours' drill on the system would be quite equal to a full day's work in the fields. Even supposing that the amount of food given was theoretically equal to the amount of work actually done, we must remember that we must bring him up to a certain level of power to enable him to do any work which he may be called on to do on the sudden. He may be called upon at any moment to do a considerable amount of work under strain, and he must be prepared to do that. A recruit may put on weight, but that is not always sufficient; sometimes it is only fat, and the reason of that is that the diet of the soldier has been shown to contain an excess of carbohydrates, that is, chiefly starchy matter, which in the body cannot all be utilized in the production of energy, and is converted into fat,

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[1] This system is the invention of Mr. Dickson, Quartermaster 24th Middlesex Rifle Volunteers. The approximate cost of the plant required would be—

1 deal box with 18 deal slabs, 1*l.* 4*s.*; 1 basket for carriage of mugs, 1*l.* 1*s.*; tin pint mugs according to the strength of the battalion at 1*l.* 10*s.* per 100 mugs.

Lieutenant-Colonel J. V. Nugent, late South Yorkshire Regiment, draws attention to a portable field kitchen in use in the Swiss Army, as follows:—"It consists of a light wagon, capable either of being drawn by one horse, or else attached to another heavier vehicle. In the rear part of the wagon are two large cauldrons or cooking-pots, in which the food (sufficient for 150 men) is going through the process of being cooked. In the front part the rations can be stored away; thus, owing to the food being cooked while the wagon is being drawn along to its destination, the soldier, after perhaps a long and laborious march, arriving hungry and tired, finds his meal all ready for him, instead of having to go through the wearying process of waiting for it."—Ed.

so increasing corpulence. But there is another point also, and that is this: General McKay has said what is quite true, that sometimes recruits have to be sent to hospital because they get ill by having too much to eat. It is not exactly that they have too much to eat, but it is a change of food which causes this. If we take a man from a remote part of Scotland who has lived all his life upon oatmeal porridge, or another man from Ireland who has been in the habit of consuming potatoes, and give him the ordinary ration of meat, it is quite possible that he will become a little troubled with indigestion, but it does not follow that the ration is too much. There is a very remarkable example of that on record in the Austrian army, where recruits come from very wild districts, such as the Croats, and when they get the ordinary rations of the army they are sometimes seized not only with dyspepsia, but with acute inflammation of the stomach. The cause is that the stomach has been accustomed to such a coarse kind of food before, that as soon as it gets an ordinary digestible ration it is perfectly incapable of dealing with it. The daily *scratching* (so to say) of the mucous membrane is no longer present, and the gastric juice is not sufficiently secreted; the stomach becomes overloaded, and severe illness is the consequence. But no one argues from that that it would be better to keep this man upon his coarse diet of indigestible roots, rather than give him the good ration which he ultimately will be able to digest. There is one point on which I am quite at one with General McKay, and that is the immense importance of supplying good drinking water everywhere, particularly in India. I have always pointed out that if there were any doubt as to the quality of the drinking water, the more suitable plan is to see that every particle of water is boiled, in which case it may be drunk with perfect impunity. It would even pay if we were to supply our troops with distilled water on their march in India, particularly in cholera times. With regard to feeding in the field, I may say that the diet which has been referred to was suggested not with a view to give it to the soldier every day in the field, but that arrangements should be made that in times of special exertion some such diet should be at hand—at any rate there should be an improvement in this direction, so as to give the man a much larger amount of food of richer material than he gets under ordinary circumstances, and there is one point which must be remembered, namely, that experience has shown that if you call upon men for great exertion, you must increase the amount of fat given, and especially if the exertion is of a sudden kind. I have had it remarked to me more than once, and it has been insisted upon, that fat is not necessary to that extent, and that even so much nitrogenous matter or albuminates are not necessary, and the example of the inhabitants of India has been cited, who are said to go through an immense amount of work living upon rice alone. This is a very common fallacy; the Indian does not live upon rice alone, but always adds something to that. In many parts of India, they live upon a kind of wheat that contains 8 to 10 per cent. of albuminates, and some even use milk. They no doubt use a very large quantity of rice, but they all add leguminous food, such as dhall, &c., and take fat when they can get it. I think the experience of everybody has been pretty well this: that the limit to the consumption of fat on the part of a native Indian, and I may say of a Southern European too, also living in warm climates, is simply the limit of his purse. With regard to the spirit ration, I do think it would be well to prohibit the issue of spirits in all Government canteens. I believe one great argument is that if you do not allow spirits to be sold in canteens in India, the men will go and drink worse spirits in the bazaars. That is quite possible, but I think if other liquor of a less dangerous kind were supplied, for instance, good beer, or red wine, the taste for spirits would to a large extent disappear, especially if in addition the men are really thoroughly fed. There are many other points that one might speak about, but Colonel Tulloch has treated the subject so thoroughly that perhaps I should not be excused if I detained you further.

General Sir WILLIAM CODRINGTON: The question of the supply of any extra ration in peace-time is not one of difficulty, but how is it to be done in time of war? Is it possible that a Government can, with the ration of meat and the ration of bread, be forced to supply—forced, I say, in point of habit—all these various articles—tea, coffee, pepper, sugar, and so on. I look upon that as very doubtful, and that being the case, it may be a better plan that the soldier should

sacrifice a little of his pay for the purpose of getting these extra things which he could claim perhaps if it was part of the ration, but if not supplied need not be charged against him.

Colonel TULLOCH, in reply, said: With reference to what Lord William Seymour said about the hour of meals, it was in consequence of many of the men having such a very poor tea indeed that we instituted the soup in the evening, because many of them had really nothing to eat after their dinner, and a very large proportion of them had and now have no food between 5 o'clock in the evening and 8 o'clock the next morning—which is far too long an interval. As regards the time of feeding on active service, that must to a great extent depend upon the necessities of the service. But I notice one possible improvement in cooking vessels, and that is the peculiar shaped iron pot or digester, which is now made use of by the Austrians. I think Professor de Chaumont brings it forward in his book; it is a most admirable invention, because, even if they have not had time to cook the meat, this iron digester is thrown into the baggage-wagon, and by the time it is cold, the meat is cooked. As regards what General McKay has said, I think all his objections have been so thoroughly and completely answered by Colonel Clive and Professor de Chaumont that nothing remains for me to say on the subject except that because soldiers had only one meal a day fifty years ago, there is no necessity why they should be starved to-day, any more than we should return to the old rate of mortality in those dreadful days in which possibly one-fifth of the regiment disappeared every year. With regard to the men getting things in canteens and backing up the canteen in every way, I venture to think the great object is to keep the recruit away from the canteen as much as possible, and the regulations lately brought out into the Service tend in that direction. If a man has to go to the canteen to get his bread and cheese he will meet some old toper there who will possibly get hold of him and very soon induce him to drink. Our recruits, I am happy to say, do not drink at all; the drunkenness almost entirely rests with certain of the older hands. With regard to water, of course no one can dispute that good water is always essential; as regards the offal you must simply take what you can get. At my present station, Mullingar, we did our best by tenders and everything of the kind, but, unfortunately, Ireland is very different, I imagine, from the glorious old days when General McKay was there. Now if one man makes a contract and attempts to deprive another of it, he is certainly pointed to if he is not shot. At Mullingar, only the other day, there were two tenders out, which two men had been in the habit of securing between them. Ultimately, one man put in his tender a little lower than the other; the result was that he was immediately boycotted by the whole town, and had to throw up the tender. I have now only to thank you, gentlemen, who have been kind enough to attend this lecture, which I am afraid has been rather a dry one, but if it tends in any way to improve the feeding of our recruits and to make strong young men of them before they are sent abroad to their foreign service battalions, your support on the present occasion will not have been given in vain.

The CHAIRMAN: Before asking you to thank Colonel Tulloch for the very interesting lecture he has given us, having taken great interest in cooking all my life, and instruction in the kitchen having been established under my superintendence at Aldershot, I think it is only right that I should say a few words. Being an old soldier, like General McKay, I am rather inclined to believe in a great deal he has said of this food question, and though I am sorry to differ from so distinguished a man as Professor de Chaumont, I am really inclined to believe that the soldier has enough to eat. With reference to the remarks made by Colonel Clive, I happened to be down at Caterham the other day, and I went round the barracks and kitchen, and asked the men if they had enough to eat; they all replied in the affirmative. I observed that there was a great deal of food left on their plates. Some of the men told me that they intended to keep this for their supper, and all, without exception, told me that they had quite as much as they could eat. If a Commanding Officer does his duty, as General McKay truly says, and sees that the regulations of the instructional kitchen are properly carried out and that the men have a proper variety of food, I think there is very little to complain of. You must remember that in the Warren cooking stove you can cook on the same fire in

five different ways :—1. The meat can be boiled and soup made ; 2. Meat puddings can be steamed ; 3. The meat can be Warrenized—which means cooked under a process by which the juices are retained in the meat more than by any other method ; 4. Pies or joints can be baked ; 5. Curries or stews made, and the potatoes and other vegetables steamed. Some little time ago, when I was in command of a brigade at Aldershot, I ordered one regiment to follow the instructions exactly, and to have the varieties of food exactly as it is laid down. I believe it was Colonel Knollys' regiment, and they being Scotchmen objected, as a Scotch regiment always likes to have soup and bouilli. This variety went on for a month, and I then went round to the dinners again and asked the men whether they still objected ; they answered "no"—they rather liked the dinners now—in fact they had got accustomed to the change, and under the very good Commanding Officer they had then—Colonel Macbean—before Colonel Knollys commanded, I believe that regiment was as well fed as any regiment in the Service ; but Officers must look after the messing, and must see that the mess money is properly expended. I even consider that Colonel Tulloch's mess money as laid down is not as well expended as it might be. It gives too much sugar and too much tea, and the money so spent might be expended in some other way. If a soldier is not to spend anything out of his pay on food certainly he requires rather more money to be paid for messing ; but considering that every soldier, if he is a well-conducted man, clears from 7½*d.* to 8*d.* a day, and that you can add another 1*d.* or ½*d.* to his messing according to the Q.R., if you like to make it 4*d.* instead of 3*d.*, Officers commanding have the recruits in their hands. A soldier, with the present messing, spending, perhaps, 2*d.* a day of his pay can be as well fed as any man could possibly wish. I have been out with many expeditions in Canada in the woods, and have lived on far worse food for months than the soldier does. General Gordon, just before he left for Egypt, said, "It is ridiculous to pamper up the Army as you do ; you never could take the field." He added, "I live on meat and biscuit and whatever I can get." If we persuade our men that they are to have such tremendously good food in time of peace, we never can feed them in war-time. Sir William Codrington knows how we lived in the Crimea. We suffered certainly, but men would have been far more dissatisfied had they been accustomed to be pampered. With regard to spirits, everyone is against their general use, but there are cases when these substitutes that are proposed—beer, French wine, and porter—are not to be had. Take, for instance, Jamaica, where porter and ales sell at about eighteen pence a bottle, and French wine at double. The men must drink water, or go out to the low drinking shops if spirits are not sold in the canteen. Therefore, in certain localities, we allow spirits to be sold in the canteen, but only in certain localities. Formerly they were allowed to be sold in England. The canteens are not allowed to be open before twelve for the sale of beer, because it is a bad thing for the soldiers to begin the day by drinking. The cavalry Colonels were for many years most anxious that their men should be allowed beer in the morning. At that time I was Quarter-master-General at Aldershot, and the local authorities resisted it. It was decided at last that the cavalry canteens were to follow the same rules as the infantry. Now, what is the consequence? In the cavalry barrack at Aldershot early in the morning the men get a cup of coffee and a bun for a penny. I think we are going rather too far in saying that our soldiers are not so well fed as they ought to be. I have been a great deal with foreign armies. I have paid attention to their messing and I have never seen them have as much food as our men. I think there is a great deal to be learnt from Colonel Tulloch's very interesting lecture. He has called our attention to a great many facts, and there is no doubt though good Commanding Officers may wish to look after the messing of their men, some of them do not know how to do it. Colonel Tulloch has drawn attention to these facts, and therefore I think we ought to be most grateful to him for the interesting lecture he has given us.

Friday, June 27, 1884.

LIEUTENANT-GENERAL SIR SAMUEL J. BROWNE, V.C., K.C.B., K.C.S.I., late Bengal Staff Corps, in the Chair.

THE PUNJAB FRONTIER FORCE.

By Lieutenant-General Sir HENRY D. DALY, K.C.B., C.I.E., Bombay Staff Corps.

THE Council of the Royal United Service Institution has done me the honour to request that I would supply a paper on "The Punjab Frontier Force." The subject is vast; embracing a period of thirty years, during which the Indian Empire was convulsed, the grand native army, of which all were so proud, rich with the glories and conquests of a hundred years—triumphs in all climates, Egypt, Afghanistan, China and Burmah—under Clive, Wellesley, Foote, Pollock, Napier, Gough, and many a good Commander—between the dawn and dusk of a May-day in 1857, broke away from their allegiance, rose in arms against us, carrying with them many arsenals and war matériel of every description.

The mere recital of the records of the Punjab Force, from the Kohat expedition under Sir Charles Napier, in February, 1850, and to the glorious defence and glorious death of young Hamilton and Cavagnari's guard of Guides at Kabul, in 1879, would, however compressed, occupy more time than is allotted for such a paper as this—no amount of hard writing could make the catalogue easy reading.

We have the carefully compiled chronicles of Paget, of the exploits of the Force on the north-west frontier, filling upwards of 450 pages, records of daring service, done with devotion and discipline, under the prestige and leading of Englishmen; by Pathans, Mohammedans of the wildest class and clan—men steeped in blood feuds, traditionally careless of life, hating every dynasty but their own; by Sikhs, descendants of the soldiers of Runjit Singh, who had wrested Peshawur from the very Pathans by whose side they had been fighting shoulder to shoulder in our ranks.

These chronicles are to us what the chronicles of Froissart were to the soldiers of his time: they bring a glow of pride, testifying the wondrous power of order and discipline, effected by the nerve and brains of a handful of Englishmen. True it is that many a noble spirit passed away, hallowed in the doing; but many remain, pressing to do whatever devotion and duty may.

After I had accepted the invitation to prepare this paper, and began to read the records, reports, and lives of the men who made the

history of the time, I felt overwhelmed at the task, and shrank from attempting more than to dot down personal reminiscences, with here and there sketches and anecdotes illustrative of the men and the times—of the deeds done, and the doers. My own reminiscences have this merit—they carry us back to the earliest stages of the Punjab Force; for I believe Sir John Coke, that rare leader of Pathans, and myself, are the only survivors of the original Commandants.

Captain Coke and Lieutenant Daly raised the 1st Punjab Infantry and the 1st Punjab Cavalry; and within seven months of their embodiment both corps were reviewed by Sir Charles Napier and served in the field under his command. As to Coke's, wrote that heroic soldier to George Lawrence: "I have seen nothing superior to it in drill—it is admirable; and both you and I saw how this brave corps fought under its excellent leader in our five days' campaign." And in the General Order detailing the fighting he writes: "As Captain Coke and the 1st Punjab Regiment of Infantry sustained the brunt of this skirmishing, the Commander-in-Chief thinks it due to this admirable young corps, and its excellent leader, to say that their conduct called forth the applause of the whole column."

The stately proclamation of Lord Dalhousie, dated 29th March, 1849, recounts how the Punjab became part of the British Empire. The treacherous murder of two British officers at Mooltan, Vans-Agnew and Anderson, in April, 1848, was followed within twelve months by the destruction of the Sikh army, the capture of Mooltan, the battle of Goojerat, and the expulsion of the Afghans across the Indus to the mouth of the Khyber Pass.

Sir Henry Lawrence was placed at the head of the new Government, with unlimited power of selecting the civil and military Officers under him; Lord Dalhousie stipulating only for his Agent in the war, Colonel Mackeson.

The defence of the frontier from Hazara to Mithunkote, at the junction of the five rivers, was a heavy task to face. It meant the control of lawless tribes, whose trade was warfare and plunder, numbering in all not less than 100,000 fighting men, levying blackmail on travellers and merchants, never combining save against Runjit Singh or Kabul.

For a thousand years and more the valley of the Indus under the Suleyman range had been studded with a line of forts and towers—ruins of which still remain—as positions and outposts against the ceaseless raids of mountain marauders.

In times not long past, in a country so difficult for military operations—with narrow defiles, mere fissures in the rocks—marauders assembled from long distances, well armed and well mounted, and carrying their food on their backs. They sacked towns, exacted ransoms, murdered Sikh, Governor, and people, getting back to their fastnesses with impunity.

The first duty which fell on Sir Henry Lawrence was the defence of this Trans-Indus frontier, and ten regiments, five of cavalry and five of infantry, were organized for employment.

Before proceeding further it will be well to turn to the small body

of *Guides*, which owed its origin to Sir Henry Lawrence in December, 1846; their organization must have been in his mind when he conceived the idea of a Frontier Force.

Sir Henry, during the first Afghan War, had seen the difficulties our army, British and native, encountered in the passes, amongst the hill tribes and northern nations, in the absence of guides and interpreters; and he resolved that in the future, within our own ranks, there should be hardy men accustomed to every region and accident of service, and familiar with every village dialect.

The Guides, originally one troop of cavalry and two companies of infantry, were raised by Major-General Sir Harry Burnett Lumsden, then a Lieutenant. Lumsden possessed characteristics for the task in a rare degree: a daring sportsman full of endurance, hardy and strong of frame, with an instinctive knowledge of men which gave him a power which none under him ever questioned. Life in the Punjab in those times was full of incidents, and few were the days which did not test self-dependence and soldierly intelligence. Henry Lawrence quickly gauged Lumsden's genius. In addition to the strength begotten by the stirring scenes in which he moved, Lumsden breathed among giants—the Lawrences, Edwardes, Nicholson, were his associates.

It is hardly enough to say that on the enrolment of the Guides each man's personal history was known to Lumsden; men from every wild and warlike tribe were represented in its ranks, men habituated to war and sport, the dangers and vicissitudes of border life, Affredies and Goorkhas, Sikhs and Huzaras, Wuziries, Pathans of every class, and even Kaffirs, speaking all the tongues of the border, Persian, Pooshtoo, &c., dialects unknown to the men of the plains; in many cases the Guides had a camp language or patois of their own. Lumsden sought out the men notorious for desperate deeds, leaders in forays, who kept the passes into the hills, and lived amid inaccessible rocks. He made Guides of them: tempted by regular pay and enterprise, many joined the corps and became conspicuous for daring and fidelity. On the border, and in the ranks of the Guides, tales, abundant in humour, were told of Lumsden's interviews with men who had defied all authority, and had never been seen in the plains but for murder and plunder.

A sketch of Dilawur Khan, who died on the path of duty, a Subahdar of the Guides, whose name is familiar in every village between the Khyber and Kashmere, will illustrate this.

When Lumsden first visited Eusofzai in search of recruits—in his own words—"of men accustomed to look after themselves, and not easily taken aback by any sudden emergency," Dilawur Khan was notorious. He had been brought up by Mohammedan priests, and was intended for the priesthood; but kidnapping bankers and rich traders, carrying them across the Indus into Eusofzai, was too attractive in adventure and remuneration, and he forsook the sacred calling.

Dilawur's capital consisted of his sword, a piece of rope, and a huge bullock's skin, which he could inflate at pleasure, and so carry himself and his guests across the sacred river; once there, a message was sent

to settle the sum the firm or family would give as ransom for his guest. This was Dilawur's occupation. Lumsden, thinking that Dilawur must have rare local knowledge and pluck to carry on such a trade successfully, sent him an invitation to his camp, promising him a safe return to the hills. The very novelty of the invitation took Dilawur's fancy, and to the astonishment of the chiefs of the district he appeared in camp. Lumsden received him with all courtesy, pointed out that in a short time posts would be so established throughout the country that his calling would be impossible, and the risk of hanging great, and ended his moral by proposing to make him a Guide. Dilawur fairly burst into a fit of laughter at the proposal, and took his departure across the border. Six weeks afterwards he voluntarily turned up at Lumsden's tent, saying he had come to join the Guides, but pleaded hard to be excused the degradation of the "goose step"; but Lumsden held out stoutly for the absolute necessity of his being taught the complete art of war, and finally had the satisfaction of seeing the most dreaded man on the frontier patiently balancing on one leg at his bidding.

Such is Lumsden's own account, and he adds: "About half my first recruits were of this stamp, while the other half were sons or nephews of the chiefs of the district," who sought the Englishmen as representatives of their family, and eventually rose to the higher ranks. So popular became enlistment under Lumsden that thirty or forty young Affredies, or Pathans, fed and clothed by their relatives in the ranks, passing through their drill, awaited vacancies. Great was the excitement at the rifle butts when a vacancy, as a prize, was shot for by these aspirants.

The headquarters of the corps were fixed at Murdan, in the midst of Eusofzai; a rude fort was constructed, and there in a rich valley, bounded on the north and east by the Swat Mountains, with the Indus and the Kabul river south and west, Lumsden held civil and military sway over a people the Sikhs had failed to subdue, and who had withstood an army with guns led by Runjit Singh in person.

I have described Lumsden's mode of selecting Affredies and Pathans, to be associated and brought under discipline with Sikhs and other Hindoos, and must now give an anecdote of the feeling of this body to Lumsden himself. Sir John Lawrence, as ruler of the Punjab, was wont from time to time to make tours through all parts of the country. On one of his early visits to Murdan, the chiefs from the hills with their followers, and every village baron, gathered at Murdan to pay the great man obeisance. Revenue assessments and cases were discussed, and appeals received. Lumsden, from early ties, was probably easy in criminal and civil matters with a people whom he found cultivating their fields with sword and matchlock by their side, and who had never paid revenue except by force of arms, and who had no law but tradition and the will of the Kazees. Sir John, though cordially relying on Lumsden's judgment, spent two or three days in cultivating a personal knowledge, as was his habit, with all that came before him, and thus it seemed to the men of the Guides

that their leader was harassed by discussions and explanations instead of being with them as usual in the field or at sports.

The night before Sir John was to march with his retinue from Murdan, Lumsden, after Sir John had gone to bed, went outside, and sat on the parapet of the fort. After awhile, an Affredi orderly, who always attended Lumsden in sport or fight, crept up to him and said, in a low tone: "Since the great Lawrence came you have been worried and depressed; many have observed this, and that he is always looking at papers, asking questions, and overhauling your accounts. Has he said anything to pain you? is he interfering with you? He starts for Peshawur to-morrow morning; there is no reason why he should reach it." The incident tells its own tale.

To return to our story. All these men were so welded together by Lumsden that they quailed before no danger, shrank from no raid, however desperate, and bore themselves to their leader against any odds with a fidelity unsurpassed by the Crusaders. In the valley of Peshawur, in 1847, Lumsden's prestige became a proverb, and with his native Officers, men of mark and name, the Guides became famous. In the following year Lieutenant Hodson joined the Guides as Adjutant. This was the famous partizan soldier who, after being conspicuous in many a stirring scene, fell at Lucknow in 1858.

During 1848, the year of rebellion in the Punjab, the Guides under Lumsden and Hodson were repeatedly engaged; their ranks repeatedly thinned, and again and again filled; their pay was above the ordinary scale for native Officers and men, and to meet the exposure, and the leading which constant service entailed, the proportion of native and non-commissioned officers was double that of the Line. The corps was self-dependent; they had no carriage save that which was carried by their own mules and ponies; their pay supplied everything; extras for foreign service, or any cause, there were none.

It may be thought that I have been too careful in sketching the life and deeds of the Guides through the throes of the Sikhs, on their transition from an independent nation in 1846, to their incorporation with the British Empire in 1849; but this handful of soldiers became the nucleus of the Punjab Force, which, modelled on the Guides, and associated with them in scores of struggles on the hills and in the passes, along a frontier of some 600 miles, became, in May 1857, not only the foundation of the present Bengal army, but, with the exception of the sturdy heroic Goorkhas, was the only available native force wherewith to stem the tide of sedition which, at a swoop, carried the Sepoy army of Bengal, from Peshawur to Calcutta, into rebellion.

I will now touch upon the constitution of the first regiments of the Punjab Force, five of cavalry and five of infantry, and the organization is on the same principle to this day. A cavalry corps was composed of a Commandant and 3 British Officers, 18 native Officers, and 588 sabres; an infantry regiment with the same proportion of Officers and 896 bayonets.

The native Officers were the sons or brothers of chiefs and nobles, on or outside the frontier, or Sikhs who had held rank and power in

the old army; men of the family of the ex-Amir of Kabul, the son of the Governor of Jellalabad, who stood by our cause in Sale's defence, were of these. The non-commissioned were mostly of the same stamp, serving on to await their promotion to the commissioned rank.

Each corps maintained its own carriage of mules and ponies, and was thus ready at all times to take the field at the shortest notice.

Within a year each regiment had settled down to guard their portion of the frontier of 500 miles, from Kohat to Mithunkote.

Three horse field batteries, each with five 9-pounders and a 24-pounder howitzer, were attached to the Force. The batteries were commanded by Bengal Artillery Officers, who had made their mark during the war. The gunners were Sikhs, who had remained faithful. There were also two companies for garrison duty, veterans of the Sikh army. With these batteries were some remarkable Sikh Officers, who had served under Avitabile and Van Courtland, in Runjit Singh's army, bearing French orders of rank; noble old soldiers they were, with a holy faith in their guns—to them objects of devotion.

The cavalry and infantry force, of necessity hastily organized, was composed in several regiments, mostly of men of Hindostan. Life beyond the Indus, away from their families, with harassing duties, and exposure in a climate very different from their own, had no abiding temptation for them: health and spirits gave way; they longed to return to the plains of India, and be with their own people. Their vacancies were filled on the type of the Guides,—the 1st Punjab Cavalry and 1st Punjab Infantry were so from the beginning,—and thus it came about that the security of that troubled border was maintained by the descendants of the restless marauders who had roamed and plundered for generations; and by their side fought Sikhs, their hereditary enemies, still conspicuous for the discipline and daring with which Runjit Singh had imbued their fathers.

The Punjab Frontier Force, in 1852, numbered 11,000 men of all ranks, and 64 guns—including old metal in position on the walls of the forts at Bunnoo and Kohat.

The Bengal army of 1857 was almost entirely drawn from Oudh; light cavalry, in discipline and horsemanship, all that could be desired; infantry, splendid in physique and perfect in movements, described by no mean judge, the gallant old Nott, "noble soldiers whose backs no Afghan had ever seen." Each regiment had some 24 British and from 16 to 20 native Officers; but the native Officers, under the system which prevailed, owed their position to length of service only. In the infantry the result was specially conspicuous. Subahdars of companies, aged and often toothless, mounted on scraggy ponies, jogged along the line of march. Gallantry in action could hardly win for the Sepoy the badge of a non-commissioned rank. It was with this mass, fresh in discipline, armed to the teeth, steeped in fanaticism, that the Punjab Frontier Force had suddenly to deal.

Mark the contrast in the constitution of the present native army, modelled on the Guides and Punjab Force. Regiments of cavalry and infantry have each a selected Commandant and seven British Officers. Native Officers, numerically as before, often men of birth and position,

always men of education; every soldier feels that he bears with him his own fate on the field—that promotion is the sure heritage of skill and valour.

In the majority of regiments, instead of one race, there is an admixture of races—sometimes by troops and companies, sometimes by men antagonistic in religion and caste.

In this commingling of tribes the army has a bond of strength which no temptation has yet shaken.

Sir Hugh Rose bore striking testimony to this as Commander-in-Chief, after the trials and struggles of Umbeyla in 1863 :—"It was due to the native troops employed, particularly to the regiments organized since 1857, that the Commander-in-Chief should submit to the Government of India a practical proof of their discipline and fidelity. Every effort was made by the Akhund of Swat and the hostile tribes to seduce to their cause their co-religionists in the native regiments opposed to them; but, with the exception of one young Bonair recruit, their sense of duty and discipline kept them true."

The mixture of races in the ranks has proved a political and social safeguard.

Of the fifty fights and expeditions in which the Punjab Force was engaged on the north-west frontier during the ten years Sir Neville Chamberlain exercised command, I will touch on one only—the expedition against the Mahsud Wuziris in 1860. This is an illustrative one. The Mahsud Wuziris were pre-eminent for plunder and violence, their raids increased year by year in daring, till, at last, in 1859, after years of immunity, their chiefs brought a body of five or six thousand men into the plains for plunder.

General Chamberlain, who passed down the frontier at this time, wrote to the Government:—"In the course of my annual tour, I see much of all classes, and nowhere do I hear the cry for justice till I come within reach of the Wuziris. Then commences a train of injuries received and unredressed. There is no more pitiable sight than the tears and entreaties of a family stripped of all their means. Supposing our backwardness to arise from fear, men and women counselled courage, saying, 'We will assist you; they can't stand before guns and percussion arms.'"

This final raid brought their deeds of rapine to a crisis. It was determined to march a column into their strongholds, which no stranger had ever approached—an entangled mass of mountains of five ranges, with their crests rising from 5,500 feet to 11,500 feet—accessible only by the defiles of the Suleyman range, channels, by which the drainage from the mountains finds its way to the Indus, varying in breadth from 1,000 to 80 yards.

The expedition, composed entirely of soldiers organized and disciplined in the way I have described, without an English bayonet or sabre in the ranks, consisted of—

Detachments of the Punjab Light Field Batteries: 3 Royal Artillery British Officers, 101 fighting men.

The Peshawur and Hazara Mountain Transport: 6 Royal Artillery Officers, 125 fighting men.

Detachments of Guide—Punjab—Mooltan Cavalry: 4 British Officers, 331 sabres.

Detachments of Sikh, Guide, Punjab, and Goorkha Infantry: 41 British Officers, 4,536 men.

In all about 5,200 fighting men—Sikhs, Affredies, Goorkhas, and Pathans of every clan—with 64 British Officers, of whom seven were Staff, led by Brigadier-General Sir Neville Chamberlain, whose presence to every man of the Force was a guarantee of success.

On the 17th April, 1860, the column entered the Tank Zam defile, a huge ravine, rugged with rocks and boulders, the passage difficult in fine weather—impassable even for elephants after a storm of rain, for the watercourses at the base of the towering mountains, wind for miles before reaching the plains; but selected as the route which afforded the best means of getting up supplies from the rear.

On the 19th, at midnight, the General marched off with the whole of the cavalry, to seize a height, followed by Lumsden with the mountain guns and 2,000 infantry.

Now began a series of marches in which miles occupied hours, the safety of followers, supplies, &c., requiring heights on both sides to be crowned until the rear guard came up. In the new ground, day by day, breastworks had to be constructed for night picquets, of stones from the hill-sides, palisaded to prevent a sudden rush from overpowering numbers; all tents were struck at dusk; half the men slept accoutred, all in uniform, and the inlying picquets were of necessity strong.

The Wuziris, with unity which is proverbial amongst men who subsist almost entirely on plunder from the plains, were gathered, perched on crags and heights, ready for every chance, occasionally fighting with desperation. One chief, seeing an English Officer with a few men reconnoitring the ground, shouted to his followers, "Now is the time to die for our faith, and to show the kind of men whose country is invaded." There was no lack of enthusiasm, a desperate rush was made, the gallant fellow died, but not until others had fallen.

The first serious opposition burst out on the 25th: the reveillé was just sounding, and all was quiet, when a volley from the picquets and the "fall in" call startled Lumsden's column of 4 field guns, 100 sabres, and 1,200 infantry, which had moved by another gorge. 3,000 Wuziris, sword in hand, burst through the picquets, 500 penetrated the camp, where a desperate hand-to-hand struggle ensued; they were driven back, leaving 132 bodies behind them; no wounded were found, though the number must have been great. Lumsden's loss was heavy also: 21 killed and 109 wounded.

The sick and wounded were now sent back; sixteen days' supplies, 4,000 shoes for the men, and shoes for the horses—for struggling over rocks and boulders had destroyed these—were taken, and arrangements made for an advance on Kani Goram, the capital, hitherto considered inaccessible.

At this time a message came from the Wuziris, that they desired a conference; the chief men appeared in camp. The General told them "there was still time to make terms; we had no wish to meddle with

their affairs, but we must have security against their plundering and murdering on the British territory, and that unless this was assured their capital would be captured." After much discussion the Mallicks said: "Why go further? Our people are rough mountaineers, difficult to restrain; blood was fresh, and bodies of relations still unburied in the sun; our country is unfit for an army!" The General replied that it was contrary to our custom to show hostility to the dead, and pointed out to them that many of their dead had been honourably buried by our troops, and that the relations might come and bury the remainder. The Mahsuds, who hold it a sacred duty to bury their dead, seemed touched for the moment; but, depending on their numbers, their crags and mountains, they roughly put aside overtures for peace, and left, warning us of their preparations.

On the 4th May the Force moved forward through a narrow cleft in the rock; 6,000 or 7,000 of the enemy were in position, the mouth of the pass was closed by an abattis so strong that guns had no effect on it; along the crags and ridges were breastworks of stone, terraced one above the other, thick with Wuziris. I will not delay by attempting further description of ground, &c., which well might lead the mountaineers to rely on their courage to maintain it.

The Force was formed into three columns of attack. The right and main attack had to carry breastworks on a crest, the last 12 or 15 feet of which were almost inaccessible, the ground below was broken, and cut up with ravines; the attacking party in groups fired from behind rocks, to shelter themselves from the fire and stones hurled from above. Casualties were thick amongst them. The Wuziris, seeing this check, leaped from their breastworks, and with shouts, sword in hand, burst through the leading men and reached the mountain guns and reserve. The ground on which this occurred was visible to both sides; the hills and crags rang with cheers from the clansmen as they watched the glistening swords. Captain Keyes, now Sir Charles Keyes, was with the 1st Punjab Infantry in reserve; putting himself at the head of a handful of men, he cut down the leader of the Wuziris, already on the flank of the guns. Thus the tide of triumph was turned. The men of the battery, under Captain Butt, never swerved; they stood to their guns and fought; the brilliant stroke was over; the Wuziris, leaving the ground thick with dead, retreated up the hill, so hotly pursued that the breastwork was carried and the position won.

Our loss was Lieutenant Ayrton, 94th, attached to the 2nd Punjab Infantry, and 30 killed; 84 wounded.

The centre and left attacks were carried with trifling loss, and the stronghold of the Wuziris fell into our hands.

During the halt at Kani Goram the soldiers who had won, encamped in order outside the walls, were permitted to visit the town under Officers, morning and evening. A Syud, watching the orderly marching of the conquerors about the city, called out to the bystanders, "Well done, British justice!" It is said this remark, testifying to the strength of discipline, touched the English General as much as his military success.

On the 9th May the Force marched back by another route towards the plains; and on the 19th, with little molestation, reached Bunnoo, where the column was broken up.

Thus the Force, bearing sixteen days' supplies for 8,000 men, led by Sir Neville Chamberlain—of whom it is not fitting to speak in such a paper as this—with a few English Officers, marched in triumph through a country which no native power had ever dared to enter,—160 miles, through clefts, over crags and mountains peopled by desperate marauders, watching and contesting every peak and point,—yet such was the force of discipline and system that three camp followers and as many camels were the only losses *en route*.

The casualties in action were 450:—

Killed:	1 English Officer.
	3 non-commissioned officers.
	100 men.
Wounded:	346.

I will not speak of Umbeyla in 1863; the expedition of a mixed force, English and native, reinforced as the necessity demanded, commanded also by Sir Neville Chamberlain, until a severe wound compelled him to hand over the command to General Garrock, though he remained in the field, and saw the successful end: the total casualties were 908:—

15	British Officers	killed,	21	wounded.
34	,, soldiers	,,	118	,,
4	native Officers	,,	20	,,
185	soldiers	,,	504	,,

Here again many well-known frontier names appeared in a distinguished manner. Wilde, Probyn, Brownlow, Keyes, all added to their reputation.

I will now quit the frontier and turn for a few minutes to the trials and glories of the Punjab Force at Delhi and Lucknow; these have been eloquently described by Kaye and Malleson, and do not call for other mention than bare record here.

Edwardes and the men of might at Peshawur and down the border so stirred the enthusiasm of the chiefs and tribes for our rule, that they submitted themselves to organization, and, proudly taking the place of the Frontier Force, kept the peace themselves, and so admitted of the despatch of regiment after regiment to Delhi.

The first corps to move, being the nearest to the road, was the Guides. Within a few hours of the massacre at Delhi, cavalry and infantry, 6 Officers and about 600 men, were on the march towards the scene. The grand old masters of India, the Court of Directors, thus wrote in August, 1858, of the Guides at Delhi:—"The corps, by the extraordinary alacrity with which they proceeded to Delhi—marching 580 miles in twenty-one days—in the months of May and June, turning off the road one night 12 miles to attack mutineers; by their remarkable services before Delhi, where for nearly four months both Officers and men were constantly in action, sometimes

twice a day; by their singular fidelity, as shown by the fact that not one man deserted, whilst 350 were killed and wounded."

For some weeks after the commencement of operations at Delhi, the only native troops with the British force were the Guides and Charles Reid's Goorkhas, the Sirmoor battalion. During July and August, the 1st, 2nd, and 4th Punjab Regiments, and 4th Sikh Infantry, squadrons of the Punjab Cavalry, old border soldiers, with new levies to meet the casualties of the daily struggles, poured in; and on the 11th September, 1857, some 3,000 men, of all ranks, of the Punjab Force, were in array outside the walls.

On the capture of the city, 28th September, the rolls were examined, when it was ascertained that the casualties in the Punjab Force during the operations were little short of 1,000. Of these, 250 were killed, including 9 British and 11 native Officers; 16 British and 28 native Officers wounded. No Punjab corps had a complement of more than five English Officers; and this number had with some regiments to be renewed more than once. In the Guides and 1st Punjab Infantry alone, 6 British Officers were killed, and 11 wounded; some were twice wounded; not one escaped without a mark.

Of those who fell I could tell of Lumsden, brother of the two distinguished soldiers, Sir Harry and Sir Peter; Travers, brother of the General who won the Victoria Cross by charging, with four or five Sikh troopers, Holkar's guns at Indore; Quentin Battye, the pride of the border, the beau-ideal of a soldier and horseman, fell amidst the wail of his men, murmuring, "Dulce et decorum est pro patria mori!" Murray—young Murray—sorely wounded in the early days of the siege, rejoined the Guides on the morning of the assault, and found his death springing a trench some feet in advance of his eager men.

Many other gallant spirits closed their course, but the names of Quentin Battye, Lumsden, Travers, and Murray were in many mouths, and to this day have a hallowing influence in the ranks in which they died.

The heavy losses caused by the lengthened operations made the pressure great for qualified Officers, but the spirit among them was high, and men pressed to serve where duty pointed. As an instance of this, Nicholson, who had marched down with a squadron of Sam Browne's, the 2nd Punjab Cavalry, brother of Brigadier-General John Nicholson—who, as recorded on his tomb, "led the assault of Delhi, but fell in the hour of victory, mortally wounded"—volunteered to join and lead the 1st Punjab Infantry at the storm; because the border men of the regiment knew him, and Major Coke and their own Officers were either disabled from wounds or dead. Nicholson lost an arm on this occasion.

Neville Chamberlain, severely wounded in July, had never ceased to cheer the army by his presence, and was the moving spirit in the dark days between the storm and capture, 14th and 28th September.

Coke recovered from his wounds, and led a brigade in the subsequent operations in Rohilkund with marked distinction.

The squadrons of Punjab Cavalry, under Probyn, Watson, and

Younghusband; the Sikhs, 2nd and 4th Punjab Infantry, under Wilde, subsequently Sir Alfred, formed part of the column which joined Sir Colin Campbell at Lucknow. The Punjab squadrons were everywhere conspicuous for gallant work; Probyn, Sir Dighton, and Watson, Major-General and C.B., both won the Victoria Cross, and the native Officers and men were worthy of their leaders. Younghusband was killed during the advance on Futtehghur.

The 4th Punjab Infantry, at the assault of the Sikundurabagh, Lucknow, vied with the 93rd Highlanders; when the bugle sound gave the signal for the attack, an eye-witness wrote:—"It was a glorious rush; on went, in generous rivalry, the Sikh, Pathan, and Highlander; Subahdar Gokul Sing, of the Sikhs, mentioned by the Commander-in-Chief, waving his tulwar above his head, dashed on 5 yards in front of his men."

In the succeeding operations at Lucknow, and throughout the campaign, the Punjab Force bore itself with conspicuous glory; many Officers, English and native—in their gallant leading there was no distinction—fell or were disabled. Wilde was sorely wounded, but recovered, and in after years distinguished himself on the frontier as the leader of the force which held him in honour. Sam Browne too—now Lieutenant-General, K.C.B., and K.C.S.I.—performed a gallant feat of arms. He was in command of a column, 250 sabres of his regiment and 350 infantry, hastily detached to save an important town in Rohilkund from falling into the hands of the rebels. He found the enemy in a strong position on a mound, within a short distance of the threatened city, with a wide tract of inundated ground in front, which prevented attack, or even approach. At midnight, with an old woman and boy as guides, Captain Browne moved his force round the swamp, and with break of day was in the enemy's rear. He halted a breathing space to refresh men and horses, for the march had been heavy. The enemy caught sight of him and at once turned three 9-pounders into action. Captain Browne, seeing a 9-pounder open with grape within 80 yards of his flank, galloped down, sword in hand, on the gun, attended by his orderly only. A desperate hand-to-hand fight ensued —the gun was captured, but not without terrible wounds to the heroic leader, whose life was saved by a native Officer, an old friend, badly wounded himself, devotedly rushing with two or three troopers to the rescue.

Sir Samuel Browne's empty sleeve and the Victoria Cross on his breast tell of the struggle and honour of that day.

The town was saved, the enemy crushed, and guns captured.

Sir William Mansfield, then Chief of the Staff, not wont to be keen of praise, described "the affair as very brilliant, the attack being made in the most soldierly manner and *secundum artem*."

The Punjab Force has, since the time of which I have been speaking, and since Sir Neville Chamberlain, shattered with wounds, left the command, maintained its reputation for discipline and daring. Wilde and Keyes have both commanded the troops amongst whom they had served as subalterns.

It was while serving as Brigadier-General Commanding the Frontier

Forces that Roberts began his career of a General, and developed that capacity for command which won the love and honour of the soldiers he led over the Peiwar, at Kabul, and to Kandahar.

In the troubles and triumphs in Afghanistan the Punjab Force bore an honourable share, with Sir Donald Stewart on his march from Kandahar, with Roberts at Sherpore, and in scenes too numerous to mention. In all these operations the Punjab troops were mingled with the army at large; but in any case the events are too recent for more than this general comment.

The Frontier Force, by May, 1857, had broadened into—

3 Horse Field Batteries, each with a Commandant and subaltern, R.A.
2 Mountain Batteries, each with a Commandant and 2 subalterns, R.A.
5 Regiments of Cavalry.
The Corps of Guides.
4 Regiments of Sikh Infantry.
6 ,, Punjab Infantry.

At which, with the exception that the horse field batteries have been changed to mountain guns, and one garrison company, and the addition of one Goorkha regiment, the Huzara, the Force still stands.

The armament has changed with the times. In the early period Brown Bess and the two-grooved rifle did not proudly compete with the long matchlock and Jezail of the Affredi. The cavalry, under the orders of their Commanders, provided themselves with arms and horses, clothing and equipments; the State supplies were confined to medicine and surgical instruments, and carriage for these only. In the Bengal Irregular Cavalry of that period the trooper had a matchlock swung at his back. The trooper of the regular regiments bore a heavy carbine, provided by the State, fastened to his saddle. The Punjab Cavalry, following the example of Jacobs' Scinde Horse, were armed with a light percussion carbine bought by themselves, and carried on their persons, for which the State found ammunition; all wore good swords, and in several regiments half of the men had lances. This order of things, which lasted for many years, has also changed, and the position of the trooper greatly improved; the State now pays him better, and supplies him with an arm of precision free of cost.

The horses of the Punjab Cavalry for a long time were chiefly imported from Afghanistan and Persia: in these countries there are tribes of dealers who for generations have been in the habit of bringing strings of horses into India; hardy, clever animals, bearing distinct marks of Arab parentage, well suited to the requirements of the trooper, and costing about 25*l.* on the average.

The Punjab Force, raised under the direct orders of the Governor-General, has never been, as regards the selection of Officers for its ranks, and promotion within, subject to the Commander-in-Chief. This, which doubtless seems anomalous to those not familiar with the working and constitution of the government of India, has proved to possess many advantages, and the Force has not suffered in discipline or prestige. The Viceroy has the power of selection from the armies

of Bengal, Madras, and Bombay. Wilde and Keyes were both Officers of Madras.

The negotiations with the border tribes, and our relations and treaties with chiefs and rulers, rest with the Viceroy, and are traditionally known to the Punjab Government, through whom work and mediation of varied kinds is conducted. The Officers and men of the Force, moving from place to place on a border of seven or eight hundred miles, are thus personally imbued with knowledge, valuable and almost necessary for life and duty. The work which falls to them could hardly be done in its daily uncertainties by the interchange of regiments of the army at large, and by Officers trained merely on the lines of military discipline, moving about under the routine of reliefs.

Discipline and military science being maintained, experience has proved that the State enjoys special advantages from having this border Force at its disposal. On all expeditions, when serving with corps of the Line, the Punjab regiments are subject to the same rules and regulations as others, and no distinction exists between them. There is no jealousy; for the Officers are drawn from the army at large, and appointments to the Force are prizes which many seek. With the men, transfers and exchanges are also frequent.

That great Administrator, Sir Henry Lawrence, trusted, however, to other means than force for quieting and civilizing the trans-Indus territory.

As the first regiments settled down along the border, Sir Henry Lawrence impressed on Medical Officers the necessity of establishing dispensaries. All Officers were specially instructed to seize every opportunity of making these institutions popular. The consequence of this was many a strange scene of war and confidence: men wounded on the hill-side fighting against us were brought to our picquets, and shouts came across the rocks for permission to bring their wounded to our hospital—even while the fight was going on. It so happened that a few days after our first occupation of Kohat, we had many casualties, and many wounded prisoners fell into our hands. Chloroform, then a new introduction in science, was used; and the fame of its soothing power spread far and wide. For months afterwards, men journeyed from long distances, merely to see the Doctor Sahib who sent people to sleep and then did what he liked with them without giving pain.

The Medical Officers of the Force, upon whose tact and capacity the success of the civilizing influence of medicine and surgery depended, were men selected for their energy and ability; and well and broadly did they lay the foundation of trust in the Englishman's skill and kindliness. As the Chief Commissioner subsequently wrote to Lord Dalhousie, "the presence of such men tends to strengthen our rule." In some cases, the English doctors so won the gratitude of the faithless Afghan that his life would have been safe and his wants attended to, where a dog, outside the camp, would have had no chance.

Vaccination all along the border was another source of power to us. Kafilas from distant countries coming through the passes with their

horses, camels, and merchandize; their women and children, were vaccinated by hundreds every year: they too carried the tale of the Englishman's power far and wide; and Hakims from Kabul and Kandahar came down to be instructed in the Englishman's art of escape from the sore disease, which carried disfigurement and death to so many of their countrymen.

Mohammedan fanaticism, often nurtured to madness by men who, after the commission of crime, have sought refuge from punishment and recognition by their fellows in the solitude of caves and rocks, at the sources of rivers, has many disciples scattered about along the border in places rarely visited by others than those who seek an asylum. These fanatics from time to time come out, sometimes at the bidding of others, sometimes of their own accord, deliberately to murder; generally the selection falls on some prominent man who is not of the Moslem faith. This to the fanatic is martyrdom. "I have destroyed the Infidel; do with me what you will." So spake the man who calmly stabbed to death, at Peshawur in 1853, the most famous frontier Englishman of his time, Colonel Mackeson, whose epitaph, written by the great Governor-General, the Marquis of Dalhousie, is sculptured on a monument facing the Khyber:—"He was the beau-ideal of a soldier, cool to conceive, brave to dare, and strong to do. The Indian army was proud of his presence in its ranks. The reputation of Colonel Mackeson is known to and honoured by all. His value as a political servant of the State is known to none better than to the Governor-General himself, who in a difficult and eventful time had cause to mark his great ability.

"The loss of Colonel Mackeson's life would have dimmed a victory. To lose him thus by the hand of a foul assassin is a misfortune of the heaviest gloom for the Government which counted him among its bravest and its best."

Mackeson's was a noble nature: death would have been proudly met by him for such an epitaph by such a hand.

Major Adams, an Officer of distinction, conspicuous at Peshawur and in Huzara as a political Officer (he was trained in the Guides), was signalled out by a fanatic and openly cut down.

Mecham, a gallant young soldier of artillery, who had served in many fields with honour, was another victim of the assassin on that border.

Healy, Carne, Tapp, good servants of the State, though little known to the outside world, met death in the same foul way, doing their duty.

Godby, of the Guides, and the grand John Nicholson, both were attacked by fanatics. Godby escaped, through the devotion of his men, with a ghastly wound. Nicholson freed himself, and thus describes the scene:—

"I was standing at the gate of my garden with Sladen and Cadell (both General Officers now), and four or five native official attendants, when a man with a drawn sword rushed suddenly up and called out for me. I was wearing a long fur pelisse of native make, which prevented his recognizing me at first; this gave time for the only native attendant who had a sword to get between us, to whom he

cried out contemptuously to stand aside, saying he had come to kill *me*, and did not want to hurt a common soldier. The relief sentry for the front of my house happening to pass opportunely at this moment, I snatched his musket, and, presenting it to the would-be assassin, told him I would fire if he did not put down his sword and surrender. He replied, 'Either you or I must die:' so I had no alternative, and shot him through the heart, the ball passing through a religious book which he had tied on his chest as a charm.

"The poor wretch was religiously mad; he had disposed of his property in charity the day before he set out for Bunnoo; his religious instructor here has disappeared mysteriously and got into the hills.

"My police orderly replied to his cry for my blood, 'All our names are Nikhul Seyn here,' and I think would have got the better of him had I not interfered; but I could not allow the man to risk his life when I had such a sure weapon as a loaded musket and bayonet in my hand."

I think I did well to speak of the frontier on which these foul scenes occurred as a "troubled frontier." They are now scenes of the past; resolute rule and the undaunted courage of Englishmen have stamped out the assassin, and put bounds even to Mohammedan fanaticism.

Sir H. D. DALY: There is one remark I should like to make, Mr. Chairman. The other day it chanced that I read one of the last letters which the Duke of Wellington wrote from India. It was a letter to Major Shaw, who was the Secretary to the Government, and he said, speaking of returning to Europe and his anxiety to do so—"I have long felt that services in this country, whatever they may be, are not recognized or rewarded on the same scale as services rendered in any other part of the world." I believe that is the same to this day. I have spoken to you of men whose names are known on that border of which I have been speaking, whose names are known throughout India and throughout the Indian army as household words; yet here, barring the great ones, the Lawrences, the Napiers, and perhaps probably Neville Chamberlain, they fall upon the English public coldly and with a chill. Services, as the Duke wrote when Sir Arthur Wellesley in 1805, services in that country are not recognized and rewarded on the scale in which they are in any other part of the world.

Major-General Sir JAMES HILLS-JOHNES, V.C., K.C.B., R.A.: Mr. Chairman, Ladies and Gentlemen,—There is little in this most interesting lecture which we have had the pleasure of listening to that requires any comment other than that of unqualified praise, but there is one point on which I differ in opinion from the gallant Officer who has given us this interesting lecture, and that is his opinion that it is well for the Punjab Frontier Force that it should be kept out of the hands of the Commander-in-Chief in India. I have no doubt that when it was first raised it was well that it should be kept as a special force, and I do not wish to see anything but a special force raised and kept for duty on the frontier, working entirely on the same lines as it is now with this exception, that it should be under the orders of His Excellency the Commander-in-Chief, and that the nomination of all the Officers should be in his hands. I think this view is now entertained by most of the Officers of the force. I was serving with them for a short period, certainly nothing in comparison to the time that the gallant Officer (Sir Henry Daly) served, nor did I hold the high position in it that he held, but still I saw a great deal of the troops and Officers, and I think almost all are now of the opinion that it would be to their advantage to be under the Chief. They felt it much in the late campaign, when they thought that there were difficulties about getting their services rewarded because they were not under the protection of the Chief, and that he did not take the same interest in them

as he took in the Officers under his own command. It is still more felt now on account of the rule which has been lately introduced into India, and which deprives Officers of their command after certain tenure thereof. Thus Officers who are still in command of their regiments are actually being turned out of their regiments and handed over to the Chief for general duty. They have held high position in the force, and having done their duty well, expect to get more important commands; but as they now have to compete with Officers of the Regular Force who have served directly under the Chief, and who are also equally entitled by their services to commands, it is only natural that they should go to the wall. The Chief must—at least it is natural that he should—look after his own children. That is a point which is very much felt now; in fact, I had a letter only two or three mails ago from one of the best Officers in the force saying that he was suddenly turned adrift, and that he had nothing to look forward to. It is this which makes these Officers all desire to come under the Chief. I will not say much more, but I cannot sit down without expressing my highest approbation of the magnificent material of the force. The men are simply splendid, the native Officers brave and self-reliant. I will give an instance of one man belonging to the 1st Punjab Infantry. He was left in the Pisheen valley, with a small detachment of from fourteen to twenty men, in charge of a large convoy many miles away from other troops. He had to bivouac in a camping ground, and he heard that he was likely to be attacked that night. He put the baggage into a small camp formation and entrenched himself with his men behind it, and at daylight he was ready for the attack which was made by about 100 or more of the Kakar tribe, and this Officer with his men was able to drive them off with great loss. This instance shows the material of the native Officers, and there are many of them like him. As for the European Officers, I am glad to say they still hold the foremost place which was held by the gallant Officers brought to your notice by the gallant lecturer, Sir Henry Daly, who is as well known for his deeds in that force as those whom he has honourably mentioned. The one special excellence of the Frontier Force, putting aside its fighting qualities, is its mobility. The system of regimental transport, which it has brought to great perfection, enables it to hold the first place in the Indian army in this essential respect, and now that a Commission is sitting at home investigating the question of transport, I cannot but express a hope that the system in use in the Punjab Frontier Force may be inquired into and taken good note of.

General Sir Frederick Haines, G.C.B.: I have really no remark to make on the lecture, which has been a most interesting one, evidently very carefully prepared by Sir Henry Daly, and put forward in a very clear manner. But with regard to the difficulty which arises as to the recognition by the Commander-in-Chief of the services of the Officers of the Frontier Force, if Sir James Hills refers in any way to the honours distributed after a campaign, I must positively and emphatically dissent from the opinions he has given. The Commander-in-Chief, as all here know, receives reports from the responsible Officers commanding troops in the field. These are most carefully tabulated with reference to the service of every individual named. It is impossible that the Commander-in-Chief can provide honours for all. It is impossible that he should be right at every point in laboriously going through these papers, but I must say that, assisted by an admirable and totally impartial Staff, the Commander-in-Chief does his best so to award honours and promotions not only to troops who serve under his command, but to those for whom he has an equal sympathy, the Officers of the Punjab Frontier Force, whenever they may have distinguished themselves. As regards the individual case alluded to, of course I personally know nothing about it, but the system now is to cut short the career of most valuable Officers. I look upon it that many most valuable Officers are turned out of the Service by this lapse of time system which has been introduced, and I have no doubt that the Officer to whom Sir James Hills refers is an Officer who has been bitterly disappointed. I daresay there may be some little difficulty in bringing men, after a long service in the Frontier Force, separated from the Commander-in-Chief, into the general line of commands, brigade or division, but I can see many cases in which a man such as General Hills alludes to may fall out of the Service in exactly the manner he describes without any fault of the Commander-in-Chief, or any neglect on the part of the Commander-in-Chief to recognize his

services. No doubt the Officers do serve entirely apart from the Commander-in-Chief, but I particularly wish to disclaim anything like favour towards those who have served directly under the Commander-in-Chief detrimental to the interests of Officers of the Frontier Force who come under his command simply for a time.

Sir JAMES HILLS: I suppose I must have expressed myself badly, but it was not my intention to say for a moment that the Commander-in-Chief did not weigh the services and tell off honours to the Officers of the Punjab Frontier Force brought under his notice for services owing to any ruling which was affected by their not being under his command; far from it, I am quite aware that all these matters are most carefully gone into and most justly dealt out by the Officer who holds that most honourable position of Commander-in-Chief in India. What I mean is that these Officers do consider themselves as not likely to meet with the same justice. I do not think they are right, but they do feel that they would be better off if they were under the Chief direct, and that is one reason why I know they desire to come under the Chief in India. General Sir Frederick Haines has not made any observation with regard to his opinion as to the point which I raised, which was simply a difference of opinion with Sir Henry Daly as to the advantages of the force being separated or not from the immediate control of the Commander-in-Chief. I think it would be better for the force that it should be under the Chief, and I should like very much to know Sir Frederick Haines's opinion on that point.

General Sir FREDERICK HAINES: I think it would be more discreet if I were to say nothing on this point. I have often written on it, but I specially avoided making any allusion to the peculiar circumstances under which the Frontier Force now serves.

The CHAIRMAN: I think, gentlemen, I may be permitted in your name to tender our best thanks to Sir Henry Daly for his very interesting and able lecture.

Sir HENRY D. DALY: In returning my thanks to you, I venture to make one comment upon what my friend Sir James Hills has said. I can well believe that individual Officers of a large force, Officers of the army serving in the manner in which he has seen them, when they are Frontier Officers, might be of opinion that it would be more advantageous to them to be under the Chief. But that is not the point here. You have, as I ventured to say just now, discipline and prestige being maintained as they are maintained, and the power which the Viceroy exercises in maintaining that force, and with great submission and deference to the Commander-in-Chief—not alone the distinguished man who sits here to-day, or others—with great deference to him, the five years' command which a Commander-in-Chief exercises over the army does not give him that power of putting his fingers upon men in every part of India in the way which I think the Viceroy can do. We have this noble force ready to go anywhere, the first self-reliant, movable force which we have ever had; the power of that force extends throughout the army, and I think, judging from the past, it would be getting on very dangerous gound if we were now to break it up.

Friday, May 23, 1884.

LIEUTENANT-GENERAL SIR ARTHUR J. HERBERT, K.C.B., Quartermaster-General, in the Chair.

ON SOME CHANGES IN TACTICS CAUSED BY THE INCREASING POWER OF MODERN FIRE.

By Captain W. H. JAMES, P.S.C., late R.E.

TACTICS may be defined as that portion of the art of war which is based on the proper employment of troops, taking into consideration the weapons with which they are armed.

The history of war shows us that since the first introduction of firearms there has been a gradual tendency to replace shock by fire. Efforts have been made—but vain efforts—not to admit this, and keep back troops to the old belief in the *arme blanche*, but the logic of facts has been too much for the advocates of the old system, and it is now universally admitted that it is fire as represented by the modern rifle which decides battles. But time is required before old views are altered by modern fact. I have been much struck from time to time in wandering over some of the battle-fields of the Franco-German war to see how much they have obtained to the detriment of troops bound by them, and I propose to bring forward this afternoon a few points which I trust you will find worthy of your consideration.

It has often been said that victory depends rather on the number of the enemy frightened than on the number killed. No doubt this is somewhat the case, but the frightening itself depends on the number of casualties. Let us suppose that to inflict the loss necessary to produce defeat in a given force 50,000 bullets be required; these will require a certain time to fire off, and the available time will depend—

1. On the rapidity of the arms.
2. The range over which they are effective.

Referring to the diagram, Fig. 1 represents the state of affairs in the days of the Great Frederick. Rigid lines and no skirmishers. Fig. 2 shows the advantage gained under the Napoleonic system of supplementing the fire of the line by skirmishers. We see from a comparison of these two figures that the effect of employment of skirmishers is practically to considerably enlarge the distance over which an enemy would suffer from infantry fire, or in other words, to have the same effect as increasing the range of the weapons. Fig. 3 shows the enlarged dangerous zone due to the introduction of rifle-fire, *i.e.*, the time of '54–'66; while Fig. 4 shows the present state of things with the modern small-bore rifle.

Now it is plain that all these improvements which increased the results obtained by fire, while those from shock remained unaffected, tended, and that very additional improvement still tends, to augment the proportion of effect due to fire to that due by shock. We know that now-a-days troops are driven from positions by fire alone, whereas in former times actual collision or shock was needed. This continual change in the relative value of the two parts of the infantry armament has involved in its turn changes in formation and in the method of occupying ground. Frederick the Great fought his battles whenever possible on open ground, to which alone his rigid formations were adapted. Over ground other than even, his processional movements were difficult and dangerous, as witness the Battle of Künersdorf, 12th August, 1759. The early wars with the French Republic showed, too, how in such ground as the fighting then took place in, the rigid line formation was liable to disaster. We see it therefore replaced by the flexible column and skirmisher formation, and later, the Duke of Wellington introduced the still more flexible battalion line covered with skirmishers.

Up to the end of this epoch, however, fire was merely looked upon as preparatory for the shock, and the tactical formations employed were all designed with a view to the ultimate use of the latter. But with the introduction of rifles—and still more of breech-loading rifles—it was soon acknowledged that the days of shock were over, and that fire reigned supreme.

The formation for shock has therefore disappeared, and the object now of all infantry formations, whether on the offensive or defensive, is to maintain a shooting line at its proper strength. This has involved a very important modification in infantry fighting arrangements.

So long as their object was to bring up a formed body to use the bayonet, so long were drill formations used on the battle-field. The men moved forward under the direction, *i.e.*, command of one man, whether the body in question was a battalion—column, or line, or even the huge columns employed by Napoleon in his later wars, and the consequence was that the number of individual actions was limited to the number of attacked points. The issue of the fight then depended on a comparatively few commanders. But now the whole circumstances are changed. Modern fire has dissolved the close formations, and the advance now consists of a number of small units, led each by an Officer, guided by one general idea, but not moving as a coherent whole in the same sense as the closed masses did in former days.

As a consequence, we find a certain tendency to return to the style of fighting which characterized the wars of chivalry—a number of combats directed to one common end, but differing very distinctly from the manœuvre battles of Frederick or of Napoleon.

Whether an army be attacking or defending a given position, it is evident that there are places round which the fight will centre, where the struggle will be severe, and others where the fighting will be of a much more tentative character, and this tentative character will be general along the whole line of battle until the object of either side is

Fig. 1.

Fig. 2.

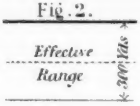


Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

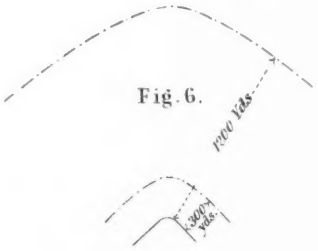
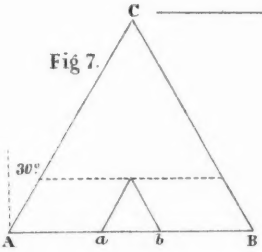


Fig 7.



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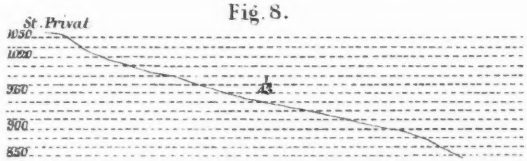


Section of ground up which Prussian Guards advanced at Gravelotte.

Fig. 9.

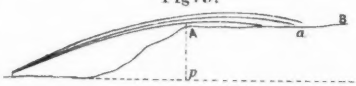


Fig 10.

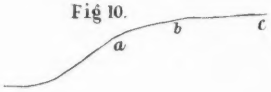
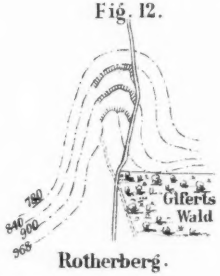


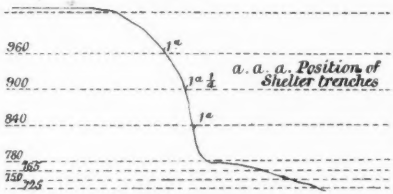
Fig. 11.

Fig. 12.



Rotherberg.

Fig. 13.



Section of the Rotherberg, Battle of Spicheren.

Harrison & Sons, Lith. 59 Martins Lane W.C.

clearly visible. This is one of the most strongly-marked features of modern fighting. Lines of battle are drawn up at such long distances from one another, and long-range weapons have so prevented close reconnoitring, that it is not until the action has been begun that it is possible to distinguish the points where the attack must be pressed home. This argument does not apply to strategically direct manœuvres, such as the out-flanking movement of the Guards and Saxons at Gravelotte, but it is well exemplified by the misjudgment of the extent of the French right at the same battle—an error for which the Germans paid dearly in the losses inflicted on the artillery of the IXth Corps.

In the future, then, we may expect battles to be entered on much more cautiously. An endeavour will be made by the offensive to ascertain the disposition of the defensive, first of all by cavalry reconnaissance, secondly, by artillery fire. But as that will be compelled by modern infantry fire to keep at a respectful distance, say 2,500 yards or $1\frac{1}{2}$ miles at the beginning of a fight, its effect will scarcely reveal the detailed arrangements of the defence, more especially as the defenders will usually be in shelter-trenches and behind cover, which will conceal their position. A tentative or reconnoitring infantry attack, therefore, becomes necessary, after the preliminary artillery duel has sufficiently progressed as to render an infantry advance possible.

Now, how shall such a tentative advance be carried out? By the modern attack formation? But it seems to me worthy of inquiry how far existing formations are suited to such an advance. Plainly, we must attack more or less along the whole line, and if we have an army which may form a line of battle several miles in length, it would appear difficult to expect an infantry advance to take place under the present ideas of attack formations over such an extended length of country. We know that at the Alma, with troops in close order, and therefore better in hand, that confusion arose; much more would it then with the men in open order. The difficulty which has chiefly to be met with is the fact that troops do not keep their initial direction, but, turned aside by ground or by fire, overlap one another or leave gaps, and that the consequence is a mixing of units, which, even if unavoidable, is nevertheless to be deprecated and put off as long as may be. Where, therefore, the fight is hottest, at the points, that is to say, towards which troops will be most directed, there will the mixing and confusion be the worst. It is, however, precisely at these points that order is of the greatest necessity. I would suggest, as a possible solution of this difficulty, that instead of extending the two companies of a battalion as at present, evenly along the front, they should be divided up into sections in single rank, but kept together or with but very slight distances between the files (see Fig. 11). These groups or fighting units would be better kept in hand by the intervals between them. The men would naturally tend to close on themselves as gaps occurred in the advance, and when it was desired to strengthen any particular part for an attack, the supports and reserves would be easily

brought into the intervals between them. By some such plan as this a commander could settle whether the fight should be tentative or be pressed home; but once the men are in extended order experience shows that all hold is lost. At the points, however, where the attack is to be pushed home, a series of battalions will often have to be thrown one on the other, and these will all tend to converge on the key of the position, and thus produce disorder. It is, therefore, necessary to support the front line of troops by others to hold the positions when won. How shall these be brought up? It seems to me in battalion line, provided intervals are kept between the companies. For experience shows that if the attention of the enemy be rivetted by a sufficiently powerful shooting line, formed bodies can move behind it with comparatively little loss.

With a view also to keeping the men in hand during an advance, which is much more difficult than when a force is stationary, I also venture to suggest that independent firing should be abolished. Troops will at close ranges use it, and no power can stop them; but allowing no one to fire without permission, *i.e.*, using volleys, would certainly tend to put off the evil moment as long as possible.

On the defensive a similar plan to that shadowed forth above might be adopted. During the preliminary stage the position should only be marked, as it were. During the first part of the infantry attack the groups, as suggested, would form the firing line, and only when the enemy's infantry got within about half a mile, should the supports be extended.

I think here is a point worthy of notice, viz., that on the defensive, supports to a shooting line, whenever possible, should, during the close infantry attack at any rate, be close up to the line they are to support; probably in deep shelter-trenches within 50 or 60 yards. It is difficult to get men to cross a shot-swept space if it be not within the limits of a run.

Fair general rules for the use of fire would seem to be as follows:—

During the tentative or first stage of an infantry fight, from 2,000 to 800 yards, the fire should be limited to those objects which are clearly seen, are sufficiently large to present a fair chance of being hit, or against those parts of the enemy's line of which it is wished to know the dispositions. Once the fight comes within the second zone, viz., 800 yards from the adversary, the fire may be strengthened to the utmost. It will, therefore, often be advantageous for both sides to make use of tiers of fire, such as the Turks employed at Plevna. This will usually be easier for the defensive than the offensive, though the latter may be able sometimes to deliver long-range fire from the second line, or even from the supports of the first.

These proposals will no doubt have somewhat a tendency to increase the expenditure of ammunition. This, however, is necessary if the long-range weapon is not to be confined to the old short range, and why it should be thought better to kill your enemy at 200 yards rather than at 800 yards I confess appears to me inexplicable.

The question of long range and ammunition supply are therefore intimately bound up. Probably the simplest plan would be to give

each man entering action 120 rounds. We are, therefore, rapidly coming to the day when kits must be carried for the men to meet the necessity for giving the latter a portable intrenching tool as well as more ammunition. Is it possible to supply ammunition under long-range infantry fire? Neither wagons, carts, nor mules could be brought sufficiently close for the purpose, and if men are relied on to bring up the cartridges, they can only carry a limited amount and may be killed. Better, therefore, give each individual a good supply to start with, and trust to making up deficiencies from the pouches of the men knocked over. This ammunition question is of the highest importance at this moment, when the introduction of magazine rifles seems to be a question of a very short time. When they are brought in, the short rapid fire from them at the closing moment will tend still more to abolish the prospect of a hand-to-hand struggle with the bayonet.

And now I will ask you to revert to my assumption regarding the 50,000 bullets. It is plain that to pour in this number in the case of Fig. 1, either the enemy must be delayed a sufficiently long time in crossing the dangerous zone, *i.e.*, obstacles must be made use of, or means must be taken to increase the length of line from which fire can be delivered, *i.e.*, it must be broken up into salients and re-entrant. Now, in old treatises on fortification and on the occupation of positions, you will find it laid down that the best way to occupy a position is to divide it up, as it were, into a series of bastion fronts, as shown in Fig. 5. By this plan, the salient points of the position, *i.e.*, those most liable to attack, are well held, and the re-entrants serve as convenient positions for artillery to flank them. The line is thus cut up into a number of points which are flanked as strongly as possible. An enemy thus advancing on the salient found himself struck both in front and flank, and the flank fire was of great importance when the time was limited in which the infantry fire could act. It was also of importance to keep the enemy as long as possible under it, and hence ground which checked the enemy was advantageous. At the beginning of this century, therefore, in choosing a position, it was desirable to have the front difficult of approach, and to have means of subjecting the enemy to a flank fire. To do this salients were a necessity, and these salients would often take the form of detached posts, which may be looked on as so many extreme salients. Taking Waterloo as an example, such points were Hougoumont and La Haye Sainte. Now, a salient is of necessity a weak point. Its sides are liable to be enfiladed, and a more powerful fire can be brought to bear on it than it can return. This is shown clearly in Fig. 6, which also shows how much this weakness has been increased by the increased range of modern firearms. The salient was formerly necessary because flanking fire was a necessity, but it was an evil, because it presented a weak point to the enemy. Under modern conditions, however, a flanking fire may be got without actually having a flank. For referring to Fig. 7, the larger triangle shows the fire which can be brought to converge on a point from the line AB under modern conditions, *ab* under the conditions of the beginning of this century. Practically, a force

advancing from C then will be four times as long under fire, and will suffer from four times the length of line it did formerly. This being the case it is plain that a flank is no longer so necessary as formerly.

1. Because direct fire has so much longer range.
2. Because the fire, even from a straight line, by this same quality of long range, is practically a flanking fire, *e.g.*, from *a*A against a force advancing from C.

It seems, therefore, that the modern position should be a straight line with very slight or no salients, which are weak places, and no longer so necessary for flanking purposes.

If this be true, the same argument will apply still more strongly to detached posts in front of the battle line.

A detached post is either so close as to be practically a salient, or else sufficiently far off to be obliged to act independently. In the former case we have seen that it is bad, and I believe it is equally so in the latter, for a detached post must bear the brunt of the attack first, and it is now-a-days exposed to so heavy a concentric fire from afar, that unless so extensive as to form in itself, as it were, a position, will certainly be destroyed by distant fire, or be compelled to yield before the force which can be concentrated against it. One of three things will therefore happen, either the troops in it will retire so early in the struggle that they will not affect its issue, or if they stop they will be surrounded and cut off, or compelled to retreat under the pursuing fire of the enemy. This reasoning does not apply to advanced positions. It may happen that in defending a given portion of ground, it may be desirable to hold a position in front to command ground advantageous to the enemy. Such a position, however, will be held in force, and although a second struggle may take place on the main position behind, it plays during the struggle for its maintenance so important a part in the fight that it may almost be regarded as the main line. Such positions were Hougoumont at Waterloo and St. Hubert at Gravelotte.

These considerations serve to show that unless for some special object, detached posts are a mistake. This I think we have exemplified at the Battle of Gravelotte, by the French holding the village of Ste. Marie-aux-Chênes, which, 2,000 yards from the French line, certainly retarded but very little the German advance.

And now as to the kind of ground in front of a position. In the old days of feeble and slow fire difficult ground in front was the best, but now with modern long-range quick-firing weapons, the most deadly ground we can offer is a smooth glacis-like slope. Such ground we know the Prussian Guards advanced over in the attack on St. Privat, and we know what their losses were. Fig. 8 gives a section of this ground sloping on an average about $\frac{1}{40}$. Compare this with the ground on the Rotherberg, at the Battle of Spicheren. Here the slope was $\frac{1}{4}$; the Prussians suffered in the crossing leading to it, and when on the top. But we know that at the base the attacking troops found shelter, and that when the attacking force—I allude to the frontal attack—gained the first shelter-trench, it was to the surprise

of the defending troops. What does this mean? Why, that the slopes were so severe that the troops could not fire down them well, *i.e.*, without exposing themselves by standing up. This same Rotherberg illustrates and confirms the danger of acute salients. The French artillery early in the day were driven back from their advanced position. The advanced shelter-trenches were carried, but from the moment the French line was thrust back to Gifert's Wald, the advance was stopped, and was only afterwards pushed on when the flanking movement through the wood was developed. The bastion-like projection of the Rotherberg, which would have been useful under old conditions to flank the Gifert's Wald and the ground to the left towards Stiring Wendel, seems to me to have been positively a source of danger to the French force in the manner it was held. Far better would it have been to have drawn the line across the neck, where the troops, unseen from below, would have received the Germans on mounting with their fire undamaged by that of their adversaries. It would also have acted as a traverse to troops told off to flank the Gifert's Wald, who might have been placed on the eastern slope. Similarly the steepness of the ground at Floing (Battle of Sedan) seems to have sheltered the Germans in their advance.

This last suggestion leads me to another point. Should the edge of a plateau as A, Fig. 9, be occupied, or should the position be taken up farther back as B, say 600 to 700 yards? A large school of French tacticians say the latter, because the portion A*a* being towards the middle or highest point of the trajectory of the projectiles fired at A, is so shot-swept, that troops in it (supports and reserves) would suffer equally with the firing line at A. Theoretically this is quite true, and practically it will happen where, as at Spicheren, for example, the edge of the plateau slopes gently up. Those present who have visited this battle-field will have no doubt remarked how from the ground below the Exercir Platz from the Galgen Hohe and from the Folster Hohe, the anterior portion of the Rotherberg is visible. In these three positions successively the German artillery acted with considerable effect against the French. Infantry coming forward to strengthen the force holding the Rotherberg were kept back by its fire; the French guns on the neck were driven back. But here was a totally different state of things to what ordinarily obtains, for it is but seldom that we find such a long intermediate slope as was here the case. In order, then, in cases such as Fig. 9 that the fire should sweep the edge of the plateau, what is required? The edge must occur in the top of the trajectory, *i.e.*, that, roughly speaking, the troops shall be firing with an elevation double that required for the range, so that the point A shall occur in the centre of the trajectory. But as A is above the firing point, in aiming at it, a certain amount of elevation will be given, and it follows therefore that the proper angle of elevation to be used would be that due to double the horizontal range, less the amount obtained by aiming at A instead of *p*. It seems to me, therefore, with the greatest respect to the theory, that in practice the danger would be less great than is sometimes imagined. On the other hand, by withdrawing from the edge we lose

the advantage of view; we cannot see what the enemy's movements are, and we limit our resistance to the short space between the edge of the plateau and the drawn-back position, which is to a great extent throwing away the advantage of long-range weapons.

As a general rule, therefore, where the front of a position consists of one long slope, the top should be occupied. Where the ground in front is as shown in Fig. 10 the balance of advantages and disadvantages must determine whether *a*, which sweeps the lower part, *b*, which sweeps the intermediate section, or *c*, the retired position, should be chosen. I think that if troops can retire from *a* under cover, for instance, through a wood or hollow road, that this is far the best, as enabling the force holding it to commence stopping the enemy from his first appearance. Failing this *c* is the best, because here the troops are safe from fire, and have a fairly wide zone in front of them. The worst is *b*, because here the enemy can approach pretty close under cover, and because the zone in front is so shallow.

The angle of slope of the ground in front will also affect the question of the position to be held. Where this is steep, as at Spicheren, the men, to fire down it, must stand up. In such a case the withdrawn position is the best, and I am inclined to think should be occupied when the ground in front rises more steeply than 10°, *i.e.*, about 1 in 6.

From what I have said, therefore, I think it is possible to lay down three general rules, viz.:—

1. The position should be as near as possible straight.
2. Detached posts should not as a rule be occupied in front of the line, and the latter should be taken across the neck of sharp salients.
3. The front line should be on the edge of the ground sloping up to it, provided this can be swept by fire, and where this is not the case, it should be drawn back 700 to 800 yards beyond the edge of the plateau.

If these rules be right, it seems to me that at Spicheren, on the central portion of the field of Gravelotte, the French were wrong. In all these cases they seem to have lost sight of the alterations in tactics due to modern weapons, of which the above given rules are the outcome.

Time does not allow me to enter into a detailed inquiry into this question, but I think that anyone who will bear these rules in mind, and will examine into many of the battles of 1870–71, will see that in all cases where they were violated, it was to the detriment of the troops concerned.

And now I must call your attention to one more point connected with the occupation of positions. It is universally admitted that the soul of the defensive lies in the power of assuming the offensive at the right moment. But if the line occupied is to be as far as possible straight, it is plain that any issuing out of it will be difficult, if not impossible, unless in the form of a pursuit after an attack has been driven back. To admit this, however, would be to limit very narrowly

the use of the offensive. On examining the matter more closely, it will be seen that this is again a question of modern alterations in old tactical forms.

In the days of Napoleon usually the most effective point to penetrate the enemy's line was the centre. It is equally so to-day, but an assailant attempting this against a strongly posted defender would, owing to the large amount of fire which could be brought to bear on him, seldom be able to succeed, and he will therefore be limited to frontal attack or to turning one or both flanks, according as numbers allow. Now in attempting this latter manœuvre it is that opportunity for an offensive return will be offered to the defender. For an enemy attempting to turn the defender's flank, himself offers a flank to attack, and it is against this portion of his forces that the counter-attack should be directed. Plainly, therefore, when a flank is liable to attack, troops should be massed behind it, not only as reserves, but also with distinctly offensive views. What might have been the result had the French Guards been on Bazaine's right flank at Gravelotte, and been able to assume the offensive when the Prussian Guards' attack was first brought to a standstill? Issuing out between Roncourt and St. Privat, they would have penetrated between the Prussian Guards and the Saxons, and have placed in deadly peril the already sorely tried IXth Corps.

These considerations, then, lead to the general deduction that, on the defensive, offensive returns should as a rule be made during the fight from the flank threatened by the enemy. This will not of course prevent a general assumption of the offensive such as Wellington always employed at the end of his offensive-defensive battles.

This rule, then, leads to the consideration of the best method of securing the flanks of the defensive position until the offensive is assumed. Looking to the fact that it is from the flank that the counter-attack is to be delivered, it will evidently be desirable to take our defensive measures bearing this end in mind, and for this purpose putting aside the case of a flank resting on an impassable obstacle, it seems to me that a strong point held in extension but not in front forms the most favourable solution of the problem, combined with the massing of troops in rear of the flank, both for offensive and defensive operations.

A defensive position, then, drawn up under these conditions, would consist of a front line, a second line to support it, small reserves to strengthen weak places, and finally general reserves for offensive purposes on one or both flanks. The point held in extension serves a double purpose. Not only does it extend the line held, and therefore forces the enemy to prolong, *i.e.*, attennate his line, but it forms a *point d'appui* for the counter-stroke, while not being liable to the concentric attack of a post in front, it is nearly as secure as any other point in the line.

I should now like to say one or two words with regard to modern artillery. It is difficult to say what the effect of shrapnel will be. It is an untried projectile in war on any large scale. Again, there is another new projectile, the double skin common shell, which breaks

up into a very much larger number of fragments than the ordinary common shell.[1] Both these will probably tend to bring up the effect of guns to what it was before; that is to say, nearer to the effect produced in the days when grape and case might be looked upon as the main projectiles of artillery. There is one thing that I think we shall see in all future wars, namely, a tendency to handle the artillery as a separate arm, by which alone its proper effect can be obtained. We shall look upon it not as a mere auxiliary, but as acting to a certain extent independently. We shall see it pushed forward early in the action, concentrated in large masses, and also used in the tentative attack which I sketched in the early portion of my lecture. But this independent action will also expose the guns more, for at the commencement of the battle the large masses of guns pushed forward with the advanced guard only as an escort would offer an opportunity to the enemy for an attack which they would not get later in the fight; such as the French had against the artillery of the IXth Corps at Gravelotte. Again, the necessity of pushing home the artillery attack involves the use of shields to provide against the increased effect of the small arms. I would suggest as a possibility that we might work our artillery on rather different principles. We should use the teams to take the guns into action, and then remove all the horses except perhaps the pair of wheelers, just sufficient to move the gun, taking the bulk of the horses and men to the nearest retired position where they can be in tolerable safety, and work the guns by relays. One of the commonest things one comes across in reading military history is the way in which guns are stopped in their movements by the loss of their teams; either you must have reserve teams, or you must separate them somewhat in the way sketched out.

It is too much to say, as is often said, that the days of cavalry on the battle-fields are gone. The elements which have always constituted the strength of cavalry still remain, namely, speed, and the rapidity which this confers of moving a large mass of men from one part of the field to another. This is a very favourable opportunity for the use of cavalry early in the battle, when the large masses of guns are pushed to the front. No doubt the cavalry would suffer heavily in such an action; but cavalry must not expect to go to war without suffering loss, and I am sure that a good dashing cavalry leader would often be able to produce such an effect against the guns as our Union Brigade did against those concentrated against the British left centre at Waterloo.

During an action also, there will be employment for cavalry in wide turning movements. You must remember that we have not seen any pitched battles fought on a large scale under strictly modern conditions, between armies of fairly equal force and organization, and we must therefore guard ourselves against making too many deductions from what happened in past wars. The only really large battle of this description was Gravelotte, where the French had their back to a

[1] See my article on "Modern Field Artillery," vol. xxvi, p. 737, of the "Journal." —W. H. J.

fortress, so there was no opportunity for any very wide turning movement on the part of the Germans. But where two armies are contending in the open country, I think it would be possible to use the cavalry divisions for such a purpose during the course of the battle. A large mass of cavalry directed against the rear of the enemy must produce an effect. It is all very well for a General to say, "Oh, that is only cavalry coming;" but he does not know it: it may be that the cavalry cover the advance of an army. Moreover on such duties cavalry would be used dismounted, and their fire having considerable effect would be an additional weapon in their hands for such an outflanking movement.

I cannot help thinking also, with regard to this subject, that the mitrailleur is the proper weapon for horse artillery. Horse artillery acting with cavalry only have to deal with man-killing—they do not want to beat down the cavalry they are opposed to; what they want to do is, the moment the cavalry are about to come into collision, to produce the greatest possible effect with fire, and it appears to me that the mitrailleur properly mounted on a four-wheeled arrangement, from which it can be fired without unlimbering, would be the proper weapon for horse artillery. I am quite prepared to admit that it would be possibly desirable for certain purposes to supplement these mitrailleurs by guns carrying common shell, but for the actual fight of *cavalry* v. *cavalry* the mitrailleur is the weapon. The power of pouring in a tremendous long-range case fire in such a position must produce a great effect on the opposing cavalry.

There is another use for cavalry, namely, for organized raids, such as the mounted infantry, the armed men on horses which the Americans employed. We know at the present moment that the Russians have a very large force of dragoons on the Prusso-Austrian frontier, and these would in all probability be used the moment war was declared for raids into the enemy's country, to cut his communications and to interfere with his mobilization. Similarly the German cavalry division in Lorraine would probably be used for the same purpose against France.

But I must now conclude. I said at commencing that I proposed to bring forward certain ideas for your consideration. I can only hope that you have found them worthy of your attention. I could have wished to have supported my propositions in more detail, but that, as you all know, is impossible within the limits of a lecture.

The CHAIRMAN: At there is no subject probably on which there are more differences of opinion than upon the manner of attack and defence, and upon tactics in general, I have therefore no doubt many Officers here would like to make some remarks upon the very able lecture which Captain James has given us.

Colonel G. MONCRIEFF: I should like to state that in a recent General Order it has been laid down that the attacking line should be fed by the supports in masses where the blanks occurred in that line, and not, as has hitherto been carried out in the "Field Exercises Book," that the supporting company should extend in such a way as to come in file by file between the files of the attacking line. I also might mention that a new valise, the invention of Captain Blakeney, is being tried at the present moment, which is calculated to carry, together with the rounds in the pouch, at least 100 rounds. The valise is only a

sort of cover to a canvas bag which contains the heavier part of a man's kit, and which would be left behind at the base of operations, or in the wagon. Inside this cover there is merely room to carry an extra shirt, &c., and four little pockets, which are easily unfastened; each pocket carries 10 rounds, making 40 rounds, and with 60 in his pouches, 100 rounds of ammunition are carried without any difficulty.

Colonel LONSDALE HALE: Captain James has put before us some rules which certainly are in the highest degree original, and, to say the least, revolutionary. There is no reason, however, that they should not be sound because they are revolutionary; but, at the same time, when rules of this nature are offered for our acceptance, we may fairly ask the gentleman who fathers them to favour us with more full and stronger arguments in their support than those which Captain James has vouchsafed us in his rather superficial treatment of the subject this afternoon. The first rule is, that "a position should be as nearly as possible straight," and he finds fault with the French in not adopting this rule at Spicheren, Wörth, and in the centre portion of the field of Gravelotte. It is impossible, without diagrams before us, fully to discuss the question; and had I known four-and-twenty hours earlier that reference would be made to those particular battle-fields, I would have obtained diagrams for the purpose; but I would ask Captain James to be so good as to append to the lecture, when it appears in the "Journal," reproductions from the official maps, and to indicate on them the exact line he thinks the French should have adopted, so that when we next visit these places we can form an opinion on the subject. It will be most interesting to learn how on the wooded and broken position of Wörth such a line could be selected. Rule 2 is, however, *the* revolutionary recommendation: it is, "that detached posts should not be occupied in front of the line."[1] In support of the rule the same battle-fields are selected. Captain James, in what I may venture to call rather a sketchy way, brings forward my old friend the Rotherberg, and he seems to have underestimated the effect produced on the attack by the holding of that advanced post. The Rotherberg was held rather as an advanced post than as part of the main line of battle; it seems very doubtful whether the French intended to fight there at all, but rather on the Spicheren heights in rear; when the French General found that the attack was serious, he sent[2] one battalion into the horseshoe trench which crowned the steep sides of the Rotherberg, and during the further course of the action two battalions of the 40th Regiment were sent there. As to what effect the occupation of the Rotherberg had on the action you will find in the official account, first of all, in its flanking fire (p. 211): A battalion of the 39th Fusiliers "took more the direction of the Rotherberg, from which they were now met by a strong flanking fire." "The 6th Company had also penetrated into the wood further to the right, suffering heavily from the flanking fire of the French Chasseurs on the Rotherberg." This was about 1 P.M. The guns on the advanced posts annoyed the Germans considerably; for we read (p. 213) that the 3rd Company of the 74th Regiment endeavoured "if possible, to approach unobserved the left flank of the enemy's artillery on the Rotherberg, the shells from which had wrought considerable damage to both battalions (of the regiment) when making their first ascent of the heights south of Saarbrucken," upwards of 3,000 paces distant. According to Captain James's account, the attack on the Rotherberg was a very small matter. But turn to the account given by the Germans of this advanced post held by one, or perhaps two, battalions at the most, for there is not room enough on it for more. "The Rotherberg (p. 214), conspicuous at a distance by its glowing red hue, projecting like a bastion from the enemy's front, and flanking all lines of approach along the open ground, must be captured, if it be our object to eject the enemy from his strong position. The difficulty, nay impossibility, of an unaided frontal attack on that point could not be overlooked, and a flank movement to the right and left was therefore resorted to with a view to facilitating the assault." Two battalions of the 74th Regiment moved against it, and the advance of the leading battalion is

[1] By "detached posts" it is presumed that what are ordinarily known as "advanced posts" are indicated. My remarks were based on this assumption, and were not objected to on that account by the lecturer in his reply.

[2] Official Account, p. 211.

thus described (p. 215): "The fusilier battalion had deployed into line with its companies at 80 paces interval, and the whole of its skirmishing divisions 150 to 200 paces in front." In this formation it traversed the open hollow between the Reppertsberg and the Galgenberg, under a destructive fire from the enemy's batteries and shelter-trenches. With every moment the losses increased, but the attenuated ranks closed again, and without a waver reached the foot of the heights. Major v. d. Mulbe, commanding the battalion, had long recognized the difficulty of the undertaking. He deemed a direct ascent of the steep and rocky slopes impracticable, without a corresponding flanking movement. Restraining the attempts of some of the more foolhardy, he ordered every man to get under cover below the heights, at the same time keeping up a moderate fire on the enemy's riflemen perched above them. As the enemy swept the entire foot of the heights from his shelter-trenches lining the edge of the precipice, cover was only to be obtained by crouching under the rocky walls. The three available companies of the 1st battalion subsequently joined the fusiliers in their shelter. This advance to the Rotherberg had taken place shortly after 1 o'clock, and until about 3 o'clock these troops were held there from advancing further. Thus, when the attention of the French was somewhat diverted to the right, an assault succeeded. Surely this advanced post had well fulfilled one of the objects for which all such posts are held, namely, holding in check attacks by the leading detachments of an assaulting force. So far, then, from the Rotherberg being an instance against such posts, it appears to be in a marked degree in their favour. But the central portion of the field of Gravelotte extending south from Amanvillers is a striking instance of the use which may be made of advanced posts; and the fact that Captain James quotes this central position in support of his view adverse to such posts shows how two people may differ in their interpretation of the facts of a battle. In the course of my work at the Staff College, I remarked the general dislike which the Officers studying there always showed to holding advanced posts in positions; they seemed to lay so much stress on the losing men in these posts that I have over and over again selected this particular case to overcome their prejudices, and from time to time I have on the battle-field of Gravelotte itself pointed out to them the part they played in the battle. Here, about 1,200 paces in advance of the main position, lies the farmstead of Champenois; it was held by the French, and on the hill on its flank, and close to it, the artillery of the IXth Corps opened its attack on the French position. The presence of French troops there in close proximity to the guns was a thorn in the side of the Germans for some hours, as there were no troops here in support of the guns, and an attack on them from the farm might have been disastrous. The fault committed by the French as regards this advanced post was not that of holding it, but that of not holding it strongly enough, so as to be able to attack from it. A little to the south lay the Bois de la Folie, 500 paces in advance of the line, and held all day by a French brigade and protecting an important part of the French line. Had it not been held, it would have afforded extensive cover for the preparation of an attack in this direction. Still further south, and some 800 to 900 paces in front of the margin line, lies the farmstead of St. Hubert, at the head of the only causeway across the Mance Ravine. After some 132 guns had come into action on the other side of the ravine against the main position and the farm, advanced post was carried, and a most valuable acquisition it proved to the Germans, for whence towards 7 P.M., the French made their counter-attack in this direction; the Farm of St. Hubert was the firmest *appui* (p. 113, sec. 6) for the maintenance of the ground already gained. You cannot afford to give up posts which on a battle-field assist so materially in delaying the progress of an enemy, and the possession of which may be of so great use to him. Captain James dislikes salients, but sometimes you cannot from a distance distinguish a salient from the rest of the line. It may be a short salient only, and yet the flanking fire from it may be destructive and of great value; such a salient is to be found in the knoll numbered 1,030, north-west of Amanvillers; from it a severe cross-fire was brought on the German guns and infantry in its vicinity. Perhaps Captain James can name some advantages to compensate for the loss of all those which have hitherto been derived from the occupying advanced posts; but, until he does so, I am afraid I cannot follow his lead in this respect. With regard to the question

of positions generally, the treatment of selection of positions is very unsatisfactory. It is very easy to coach up young gentlemen with regard to positions by book, and to tell them what is right and what is wrong, but when you come to have to deal with positions on the ground, all accepted rules will have to be modified to such an extent as to be hardly recognizable. So far as Officers are concerned, the only way in which they can learn how to take up positions is by working out occupation on the ground itself, on various kinds of ground. When our Generals take out the Colonels, the Colonels the Captains, and the Captains the subalterns, and teach the work practically, then, and not till then, will the Officers of all ranks, teachers as well as taught, become proficient in this necessary part of a soldier's work.

Captain JAMES, in reply, said: With regard to what Colonel Moncrieff stated as to the General Order, I do not think that quite meets the point for which I contended, namely, that infantry should never be extended absolutely in the way that companies are extended in the front line, but that it would be better at first to keep your men in groups. And now with regard to Colonel Hale's criticisms. I feel very great diffidence in replying to them, because I feel, after the very strong attack that he has made in opposition to myself, that it is I who ought to have been the listener and he the lecturer. But, at all events, I will try to meet his statements as far as I can, so that you may be able to follow me, because it is of very little use to mention a mass of names and positions, as Colonel Hale has done, unless you are all in possession, as he, of sufficiently accurate knowledge of the facts, or have a *précis* of the movements and maps of the ground before you. Now, first, with regard to detached posts, Colonel Hale says the Rotherberg was a detached post. This I deny, and any one who reads the official account of the war of 1870–71 will see that it was in reality part of the main position of the French. It was a salient, and a salient which, although it had a great influence on the action, did not affect it so very strongly as Colonel Hale appears to think. Colonel Hale read some extracts from the official account, but he did not allude to the point which I alluded to. I have brought the book with me, and I think he will find at page 219 that when the men did get up there the French were surprised at seeing them. Now, if they had seen the Prussians coming up the slope, how was it that they were surprised when they got there?

Colonel HALE: I have the book in my pocket too, and I find it says, "The moment for assault was happily chosen, in so far as at this time the firing from the enemy's shelter-trench was on the wane. The adversary's attention was turned more to the right." That is the nature of the surprise.

Captain JAMES: It would not have been a surprise if it had been all open ground over which their advance could have been seen. The reason that enabled them to surprise the French was that the ground was so steep the latter did not see them coming up.[1] Colonel Hale said that in all probability the French intended to have fought the action further back. If they had done so they would certainly have avoided the Rotherberg, and had a much stronger position without this weak point to let the Germans in at. The Rotherberg is of use to afford flanking fire to the Gifert's Wald, but it suffers from the faults to which all narrow salients are liable, viz., that they are swept by fire, front and flanks. This is shown by the fact that the French guns there were taken in flank by the German artillery on the Winterberg

[1] Colonel Hale's quotation was admirably chosen to support his argument; but he did not read sufficiently far on the page indicated, which runs as follows, and clearly proves the point I was aiming at, viz., that the steepness of the slopes of the Rotherberg prevented the French firing down them. Readers will kindly remember that I have not quoted the Rothenberg as a detached post, which it plainly was not, but only as having too steep slopes and being too salient. The further quotation is (see p. 219, vol. I, Official Account): "Leaving a small detachment in rear, the fusiliers of the 74th Regt. . . . . commenced scaling the steep and rocky slopes," at the foot of which they had previously taken shelter after the loss sustained in crossing the open ground leading to the bottom of the Rotherberg (see p. 216, *ibid.*), "after a few minutes the foremost shelter-trench skirting the edge was reached to the evident *surprise* of the French riflemen." The italics are mine.—W. H. J.

(see p. 210, Official Account). I think it would be rather out of place on my part to detain you while refuting in detail all Colonel Hale's statements; but I distinctly join issue with him in what are apparently his views with regard to the central portion of the field of Gravelotte, from Amanvillers to the Bois de la Folie. I am perfectly aware of the losses of the IXth Corps Artillery. But they suffered because they were pushed too close to the enemy without infantry support, which rendered it possible for the French to occupy the farm of Champenois as a species of counter-attack. This is clearly shown by reference to the map (Official Account, 6th section; also p. 37, *ibid.*, and p. 181, Hoffbauer's German Artillery). The farms of L'Envie and Chantrenne, which the French held in the same part of the field at the commencement of the fight, were carried with ease (see pp. 26 and 28, Official Account). When infantry was available Champenois was also captured (see p. 37, Official Account). The occupation therefore of this farm, possible and desirable as it was after the German error, cannot be quoted as an argument in favour of detached posts.[1] But I do think that the instance I have given of Ste. Marie-aux-Chênes bears out most fully what I have stated with regard to such positions. It did not materially check the advance of the Prussians. The official account (p. 59, Sec. VI) says most distinctly that the actual resistance in the village was slight. Now we know that the defenders were driven out with very considerable loss—in prisoners alone several hundreds. I am perfectly well aware, with regard to a place like St. Hubert, that it was absolutely necessary to hold it, but I am inclined again to regard this, not as a detached post, but rather as an advanced position. Everyone who knows the ground, or who reads the official account carefully, will see that it was more useful to the Prussians than to the French. To them it was a work to protect the bridge-like road over the Mance valley. I quite agree with what Colonel Hale says about using rules for occupying positions. You must occupy your position according to circumstances, and according to the nature of the ground. But having ascertained those circumstances, and seen what is the nature of the ground, you must then start on some foundation in theory, otherwise you could have no guide for anything whatever in war. I think that general rules are distinctly of use in occupying positions. As the greater portion of Colonel Hale's military career was passed in teaching, I quite understand his views when he says that it is very easy to lay down rules in coaching young gentlemen (easier, I think, than to do so with old gentlemen), but that they are very difficult to apply when you actually go on the ground. So they are; but what are you to do if you have not any rules to start with; if you have no idea whether you want one man or a battalion, whether you want two guns or twenty guns, whether your line should extend 1 mile or 10 miles, whether you want two men per yard or 2,000? Therefore, I say most distinctly that rules are a necessity. It is their wooden application which is the ruin of the people who apply them. The men who say, "I did it according to the book," are the men who suffer. Colonel Hale has vouchsafed no arguments to show that my proposed rough rules for occupying positions are, as he

[1] The possession of La Folie copse was doubtless advantageous to the French. Flanked from the main position in rear, and strongly held, it stopped the advance of the right of the IXth Corps. Still the position behind about the farm of La Folie is very strong; approached in front by a long glacis-like slope, so that even if the wood had not been occupied, it is doubtful if the Germans would have made much progress here, for there is no ground from which they could have prepared their attack by artillery fire. With the hither edge of La Folie wood entangled, and so rendered impassable, the open space between it and the Bois des Genivaux, swept as it was from the ground occupied by the right of Frossard's corps, the main position in rear would still have been as difficult to capture, although the Germans would have been somewhat closer to it. But La Folie wood, held in the strength it was, can scarcely be regarded as an "advanced post." It was in reality the main position here, differing, therefore, very materially from the cases of Champenois, L'Envie, and Chantrenne. Moreover a force of six battalions, the French strength here, possesses so much greater inherent capability of resistance than the garrisons of such small posts as the three last named, that Colonel Hale's argument as to the value of advanced or detached posts does not apply.

states, unsatisfactory, beyond his opinion that such is the case. I venture to think that this destructive kind of criticism, which enables anyone to say that no rules are necessary, is of a very easy character to begin with, and also that such a theory would be a very poor aid to any man who in actual service was called upon to carry out the occupation of a position, or any other military movement.

The CHAIRMAN: We have had a discussion between two very able Officers on the advanced and detached posts, and I think that if we establish ourselves as a jury we shall come to the conclusion that the theory of the abolition of advanced posts is scarcely sufficiently developed to enable any General to give up occupying them. General rules for tactics of course must be studied, and the Officer who understands all rules, and who is able to adapt those rules, is more likely to be a good and useful Officer than one who has never studied them. This is self-evident, it appears to me. All who have read about the late engagements must be of opinion that independent firing ought not to be allowed, except with skirmishers. As Captain James very truly remarks, in future wars probably kits will have to be carried, or left behind. They are not likely to be carried in carts, because no nation will be able to have transport sufficient. The men will have to carry the few articles they require on their backs, and to make them last for the short wars. The men will have in their packs merely their ammunition and the rations they require, with perhaps a very few other articles. The Prussian Government is so alive to this matter that it has offered a very large reward to anyone who will bring forward by December next a new equipment of a lighter description, and it lays down as a basis that there ought to be two packs, or two valises, or two bags, one in which the clothes of the man can be carried (which will be left behind before he goes into action in some store, or some railway station, or some place from whence it can be forwarded afterwards); and the other to carry the ammunition and rations I have alluded to just now. I am sure we ought to be very much obliged to Captain James, whatever difference of opinion there may be between him and my friend Colonel Hale as to the merits of the different actions they have described, with both of which they are intimately acquainted. Although I have been over the ground three times, I am perfectly certain that I am not competent to decide between them. I may, however, say that I do not think an elevated position is at all a good one to defend. We had a specimen of that at Majuba Hill, where the ground was so steep that it was totally impossible to see the enemy until they got quite close. Any skyline where men are placed is the worst position to defend. Whatever other differences of opinion which may exist, I am sure you will all agree with me in thanking Captain James for the very able lecture he has given us, and I am sure we have all been very much interested in it.

Friday, July 4, 1884.

MAJOR-GENERAL H. A. SMYTH, R.A.,
Commanding the Woolwich District, in the Chair.

MACHINE GUNS IN THE FIELD.

By Captain the Right Hon. Lord CHARLES W. D. BERESFORD, R.N.

IN reading a paper to this Institution on "Machine Guns in the Field," I feel, as a Naval Officer, a certain amount of hesitation in taking up a question which perhaps the Officers of the Army might naturally think peculiarly their own; at the same time it must be remembered that the Navy has had more actual experience in the working of machine guns in the field than any other branch of Her Majesty's Service; and guns for this purpose are supplied to the Naval Service, but not to the Army. After Colonel Sir Charles Nugent's most admirable papers on "Imperial Defence,"[1] in which he treats of the speed and manœuvring of war vessels, I indulge in a hope that the question of machine guns in the field will arouse a great interest in the sister Service, although it is brought forward by a Naval Officer. It is not my intention to trespass upon the ground which belongs exclusively to the Army, by giving an opinion as to which branch of the Military Service machine guns should be attached, or how they should be used; I merely propose to state a number of facts, repeat a number of opinions which have been given on this subject, make a few suggestions, and invite criticism on those facts, opinions, and suggestions.

A machine gun proper is a gun without recoil, in other words, a gun which does not require relaying after every shot; and there are two entirely distinct kinds of such guns: the one a shell-firing gun, and the other a bullet-firing or rifle-calibre gun. International law does not admit any explosive projectile under 14 ounces in weight, which would mean about $1\frac{1}{4}$ inch diameter, and the weight of a machine gun throwing such a projectile would detract from its value as a machine gun, making it almost artillery.

An army has a recognized proportion of field artillery to every 1,000 men, and it is hardly likely that any General would care to increase or decrease that proportion by a new weapon so nearly allied to artillery as a machine gun throwing shell would be. Opinions have been expressed as to whether two batteries of light 3-pounder machine guns would not be more generally useful than one battery of 6-pounders, but many considerations have to be thought out besides the apparent

[1] See Journal, No. CXXV

advantage of having twelve light guns in action instead of six of heavier calibre.

The number of horses, ammunition, wagons, space on the march, space in camp, &c., are difficult questions well known to all Generals Commanding and Officers in the Army, who, I believe, do not question the superiority for general purposes of a battery of 6 or 12-pounders over two batteries of half their calibre. I mention this to show why, in this paper, I do not touch on machine guns of such a character, but confine myself to the small-bore rifle-calibre gun. In all the late wars that England has been engaged, the machine guns throwing bullets have taken an active and prominent part, and although all opinions agree as to their merit for defensive purposes, opinions differ considerably as to their value for attack. The German decision of fifteen years ago—expressed by saying, "the Artillery don't want it, and the infantry won't have it"—still finds favour with the many, notwithstanding the immense improvements in accuracy, lightness, and rapidity of fire this class of gun now possesses over the old French mitrailleurs. At the commencement of the Franco-German War in 1870, the new mitrailleur was talked about in whispers; it was said it was the most deadly weapon that had ever been invented; stories were told as to the extraordinary result of the experiments it had been subjected to. No doubt all this was correct so far as private practice went, but what occurred when war broke out? Whole batteries were manned by men and Officers who had never worked or even seen this new and complicated war machine (this alone was enough to invite a disaster); they engaged artillery at distances which were beyond the mitrailleur range, and were immediately punished severely by the artillery, and placed out of action in a very few rounds. Their equipment, mounting, and organization were precisely the same as a field battery, showing quite as large a target; and they always endeavoured to use them as guns instead of as clusters of rifles, which they really were. In fact there was no possible mistake which the French did not commit with their mitrailleurs in the earlier part of the war; and it was not until later that the man-killing power of these guns was fully proved. It is worth while quoting a few examples.

The Duke of Wurtemburg, in a description of the battle of St. Privat, says:—

"During the action at Ste. Marie-aux-Chênes, Prince Hohenlohe, commanding the Artillery of the Guard, had collected 84 guns opposite St. Privat, and cannonaded the French position with great effect, at first at 2,640 paces, and afterwards at 2,000 paces. About five o'clock in the afternoon the Commander of the Guard considered the enemy to be sufficiently shaken for him to risk an assault across the open and gently ascending ground. The 4th Brigade of the Guard (Kessel) first moved forward from Habonville in the direction of St. Privat, in line of columns in two lines, with skirmishers thrown out in front; and a quarter of an hour later the advance of the 1st Division of the Guard (Pape) commenced in the same formation from Ste. Marie-aux-Chênes, distant about 2,640 paces from the main French position. Habonville is about 3,960 paces, therefore the three

brigades came about the same time within the effective reach of the enemy's fire. The front of attack included little more than 2,000 paces, so that there were about 10 men to the pace. This was however the closest formation of attack employed by the Prussians in the campaign."

"*The effect of the enemy's fire even at a distance of more than* 1,500 *paces was so murderous, that according to the accounts received nearly* 6,000 *men fell in ten minutes, and the advance had to be immediately discontinued.*"

The battle of Mars-la-Tour affords another example. A Prussian Infantry Brigade supported by the 2nd heavy battery advanced against Grenier's division. The official account is as follows :—

"In passing over the bare hill-side which falls at first with a gentle slope to the oft-mentioned valley in front of the French position, the troops were received with a murderous musketry and mitrailleuse fire. Upon this the second line moved up to the skirmishing line to fill the vacancies in the rapidly thinned ranks, and then these companies proceeded to make alternate rushes of 100 to 150 paces. All five battalions at length came within thirty paces of the French line. A withering volley is poured in, but the brave battalions are forced to fall back into the valley beneath, and the fire of the adversary from mitrailleuses advancing to the crest increases the losses *almost to annihilation.* Cavalry were then pushed forward by the Prussians to protect the shattered remnant; but *on account of the violent mitrailleuse* fire the leader was unable to deliver home his attack."

The five battalions of the 38th brigade, which went into action with 95 Officers and 4,546 men, sustained a loss of 72 Officers and 2,542 men killed, wounded, and prisoners. The proportions between killed and wounded being 3 to 4!

In fact, on the few occasions in which the mitrailleur came into action in a position in which a machine gun would be useful, its effect was simply devastating, although the French handled them so badly. The Prussians never lost an opportunity of decrying the mitrailleur, but was it not likely that that was done to diminish the fear their own men might have of them? and it is most probable that, as they invariably brought their field artillery fire to bear upon the mitrailleur batteries in preference to other opposing forces, they thought it safest to silence them at once.

Opinions seem unanimous as to the value of machine guns for defensive purposes; the moral effect of their fire in repelling an assault is unquestionable, because of there being no time for the enemy to advance between the discharges; their accuracy within limits of range; the certainty of being able to fire with great rapidity if needed; the few men required to work them; and the very small target they present for an enemy to get his sights on. How useful a few guns of this description would be in defending earthworks or villages, captured positions, houses, bridges, plantations, or even for holding advanced posts; and in a war how much would depend upon holding certain positions such as those mentioned! Within their range their power of pumping or raining bullets would have as great a moral

effect as the firing of shell from a proportionate number of artillery, and the bullet fire would be more continuous than either shell or shrapnel.

During the recent trials at Poona of a Nordenfelt 10-barrelled gun, served by six men, the results, as shown in a four minutes' test, by the hits (taking an average), were equal to the fire of 70 men with rifles, and 80 per cent. better than the hits from four 7-pr. mountain guns. The importance of the use of vertical fire from such a gun was also shown. Colonel Holberton describes how, during these trials, a canvas sheet 100 × 50 yards, was pegged down upon the slope of a Deccan hill, presenting at 1,700 yards the semblance of a road, upon which a small flag was flying. Extemporised means for finding the elevation were resorted to, but after this had been once obtained, 293 hits resulted from a discharge of 300 bullets. Surely this is most effective practice. Two such guns therefore might hold a position that would require 140 men, but the guns would have the advantage of showing a smaller target, of far greater accuracy of fire, as the machine gun has no nerves and does not want relaying after every shot; while the arrangement for spreading the fire laterally is excellent, and the vibration allows it to do its own work in spreading bullets vertically. In addition to the foregoing advantages, as it takes up so small a space, it would be most valuable in short flanks, or where there was a limited front, which, from want of room, no infantry could command with the same deadly fire. For holding or clearing a street or a gap these guns are perfect, as was exemplified in the work of the Gatlings and Gardners with the landing party at Alexandria in 1882.

I will now approach a question about which many arguments and contrary opinions have been expressed, that is, whether these guns should be attached to the artillery, the cavalry, or the infantry. As a seaman, I will not venture to give my own opinion on a question so essentially a military one, but will give a few opinions I have received from Officers attached to different arms of the Service, some of whom, while approving of the machine gun, are doubtful whether it could be attached to the arm they represent, but all of whom admit its utility under certain conditions.

A Colonel commanding an infantry regiment in India writes as to the use of machine guns:—

"They could on all occasions be used as an escort for artillery. The conditions of modern warfare necessitate that the assault on a position must be preceded by a heavy artillery fire, sustained almost up to the moment of actual collision. It follows, therefore, that for the proper and effectual performance of this duty the artillery must move well away and act from a flank, as no infantry in the world will stand artillery firing over their heads for any time. This being so, necessitates the employment of a large escort, and there can be no doubt, if you could move infantry about quick enough, it is the best of all arms for such work. You cannot transport infantry with sufficient rapidity, and therefore in most instances cavalry takes the duty. Now if you can mount and move machine guns as fast and over the same

FIG. 1.—10 BARRELLED GUN, FIELD CARRIAGE AND LIMBER.

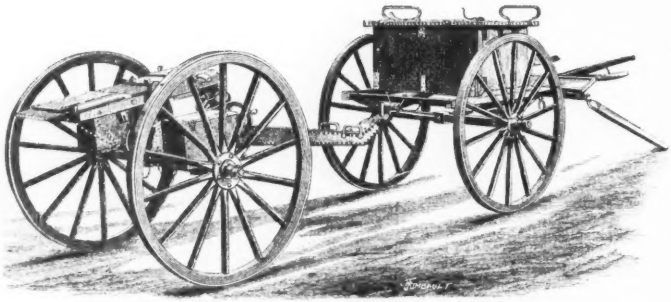


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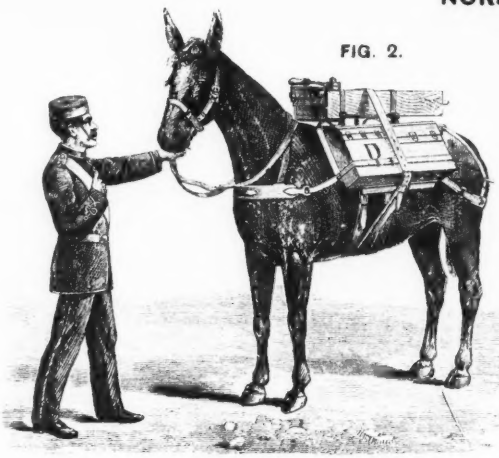
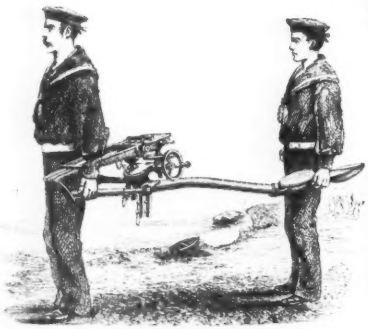
FIG. 2.

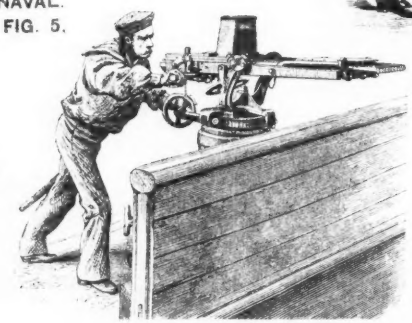


METHOD OF MULE

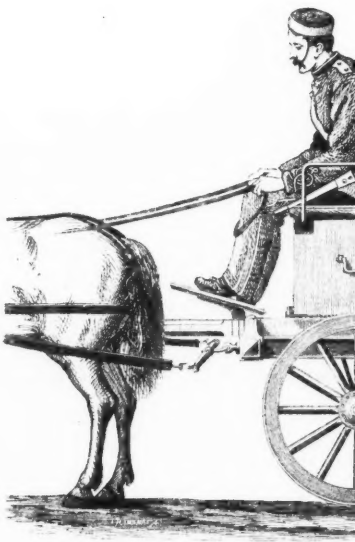
NAVAL.
FIG. 5.



CARRYING 3 BARRELLED GUN AND CARRIAGE.



INSIDE BULWARK MOUNTING.



NORDENFELT (

FIG. 6.

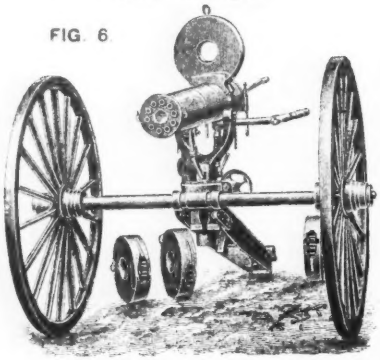
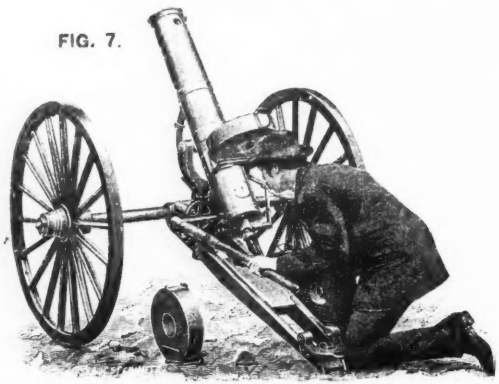


FIG. 7.

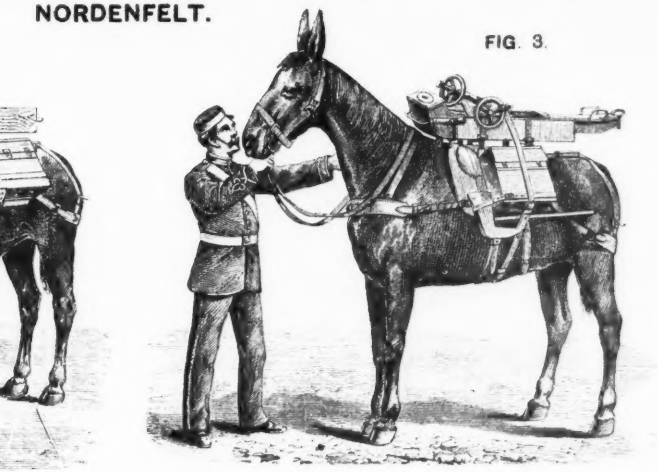


GATTLING GUN WITH IMPROVED FEEDING DRUM.

Harrison & Sons, Lith. S

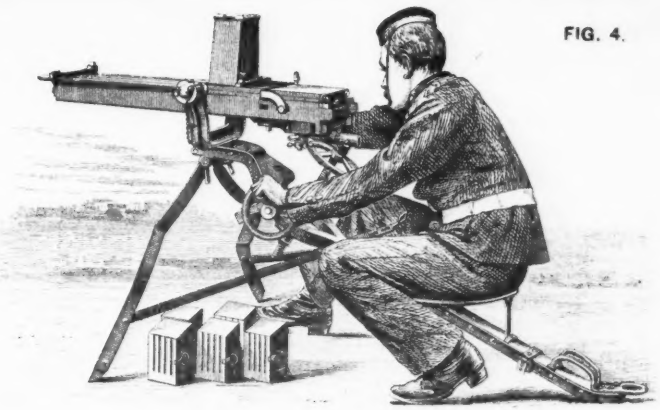
NORDENFELT.

FIG. 3.



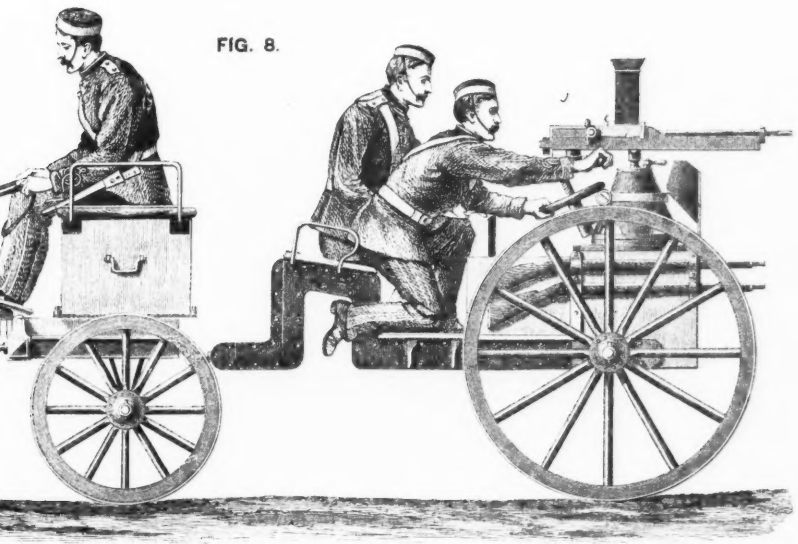
OF MULE TRANSPORT (5 BARRELLED GUN).

FIG. 4.



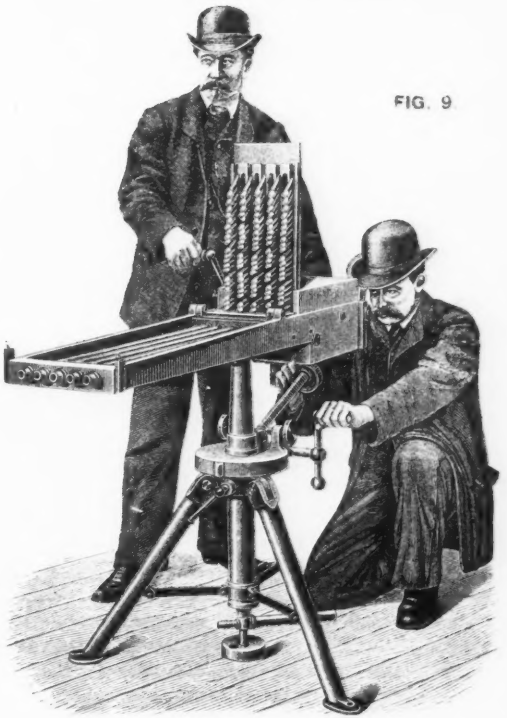
5 BARRELLED ON TRIPOD STAND.

FIG. 8.



RDENFELT (5 BARRELLED) ON GALLOPING CARRIAGE.

FIG. 9



GARDNER (5 BARRELLED) ON TRIPOD STAND.

n & Sons, Lith. St. Martins Lane W.C.

ground as artillery, what better escort could they have, as to all intents and purposes they would have always on their exposed flank as many infantry as may be considered necessary? Before moving into position, of course cavalry would have closely reconnoitred and searched the ground selected for the massed artillery to act from; but once having done this, they could safely leave the artillery protected by the machine gun, and be free for other employment on other portions of the scene of action. Had there been a couple of 10-barrel Nordenfelt guns with the artillery at Maiwand, the guns would never have been lost, the cavalry would never have been kept so many hours inactive under a heavy artillery fire, and the day would have been saved." He goes on to say:—

"With cavalry and mounted infantry machine guns would be invaluable. Cavalry, to be of any use, must, in an enemy's country, be a long way ahead of the infantry and the rest of the army, and this distance is only limited because cavalry is not a self-contained arm. With two 10-barrel Nordenfelts (Plate XXIX, Fig. 1) permanently posted to each regiment, which can manœuvre and move with it, how economically yet how enormously has the power of cavalry increased! It has practically always with it 150 infantry who can be brought into action at any moment, and not a single man has to dismount. They are all in the saddle ready to complete any advantage gained by their machine guns.

"Fancy the advanced cavalry of a large force armed as above working against an enemy's cavalry having no such adjuncts. The result is obvious, and the force with the adjuncts would assuredly penetrate the enemy's cavalry screen, get at the main body and hurl it back on to its infantry a disordered mass. I think few will contend that a brigade of cavalry of three regiments with 6 machine guns, representing 450 infantry, would not overwhelm a much larger force without machine guns. Both sides would naturally be provided with horse artillery, but being of necessity without artificial cover, I maintain that you could (ground being favourable) work the machine guns up to within their own range of such artillery, and they would, as infantry would do, drive them out of the field.

"To me it appears as if cavalry is the arm which will profit most by the introduction of machine guns. It will, to them, supply a long-felt want, and will render them a self-contained force . . . Being infantry without nerves, they will find a happy home and welcome in this portion of an army.

"It seems to me that these guns are bound to be an all-important factor in deciding the result of the next big European war; and the nation which employs them, and thoroughly understands their technical working and organization, will assuredly come off victor. The result will be, if anything, more electrical and startling than the defeat of the Austrians by the Prussians in 1866: a fact which was entirely due to the superiority of an indifferent breech-loader over a good muzzle-loading rifle."

A Colonel of Artillery gives his views as to the use of machine guns as adjuncts to batteries when escorts are not available:—

"A machine gun to be of any use for this purpose must be able to manœuvre at the same pace as the battery which it supports. With mountain and heavy batteries, whose pace is a walk, this is perfectly possible by carrying the guns on pack animals. To batteries of this class I think they would be valuable auxiliaries (Figs. 2 and 3).

"For mountain artillery they would be specially suitable. They would greatly increase offensive and defensive power at ranges from 100 to 1,500 yards. Their chief use would be the defence and attack of defiles, the defence of small fortified posts such as we held in the line of communications in Southern Afghanistan, and in repelling attacks at close quarters, as at Ahmed Keyl and Maiwand. There is the more reason for their use here, that the shrapnel fire of these batteries is weak.

"For horse and field batteries the problem is more difficult. No toy carriage with small wheels can be relied on for transport purposes. Such a carriage can be used and should be used as a fighting carriage for a machine gun in the same way as it is used in the mountain artillery. If, however, a very light gun with a good tripod arrangement, such as the 3-barrel Nordenfelt, were introduced, it is possible that the tripod might take the place of wheels, since both gun and tripod can be carried about quickly by the detachment (Fig. 4).

"The great difficulty of working machine guns with horse and field batteries appears to me to be this: How can you transport them so as to be suitable for rapid movements under service conditions? It comes to this—you must carry them about on carriages and wheels which shall not be less strong than the other carriages of your equipment. No system of carrying them on our already fully weighted gun or ammunition carriages will answer. They must have a separate equipment, and this means an addition to the Officers, men, and horses of your battery. Unless this is conceded, it is hopeless to think of machine guns as auxiliaries to field artillery."

A Colonel of the Royal Engineers says: "About the tactical employment of the machine guns I have thought a good deal, and my strong opinion is, that if they are adopted they cannot possibly be attached as an integral part to either cavalry requirements, artillery batteries, or infantry battalions, and that they must either be kept in batteries by themselves (which would be the most satisfactory plan), or else be handed over to the Royal Engineer Companies.

"I cannot conceive their being permanently attached to Cavalry or Artillery without constantly hampering them, as it would only be on rare occasions that they would be required; on these occasions they would always be available. Until they are made much more formidable than they seem to be at present, I do not see how they can possibly take the place of an escort for Artillery . . . There is a good deal to say in favour of their being in charge of Royal Engineer Companies. They could thus be introduced without an increased establishment, and consequently expense, except for home, as at the times when they would be required for action, sappers would usually be unemployed in the reserve, and could spare the gun detachments necessary to work them. Also it seems to be universally admitted that whatever the

value of the machine gun under other circumstances, it is without doubt specially suited for flanking the ditch of a fort, and for other employment in connection with defensive works, and here there would always be sappers available to work them. I am aware that at times, especially in offensive actions, every sapper is required for his own work at the front, but this work would very generally be the strengthening of a position, village, &c., just carried, and here the machine gun in the hands of sappers might be invaluable."

Lord Chelmsford writes: "On the advance to the relief of Ekowe, two Gatling guns accompanied the column, and at the battle of Ginginhlovo did considerable execution amongst the Zulus *at the opening of their attack*, which commenced on the north side of our position. The Zulus very soon, however, worked round to the west and south side of our laager, and the Gatlings were not in action therefore for any length of time.

"At Ulundi we also had two Gatlings in the centre of the front face of our square. They jammed several times in the action, but when in work proved a very valuable addition to the strength of our defence on that flank. Machine guns are, I consider, most valuable weapons for expeditions such as that which we had to undertake in Zululand, where the odds against us must necessarily be great, and where it is necessary to leave small detachments in charge of posts along the line of communications. The Gatlings, however, required too much care in firing, and could not be entrusted to any but skilled manipulators; if a machine gun can be invented that may safely be entrusted to infantry soldiers to work, and could be fired very much as one grinds an organ, I am satisfied of its great value. They should, however, in my opinion, not be attached to artillery, but should be considered as essentially an infantry weapon, and should be worked by infantry soldiers; so utilized, they might, I feel sure, be used most effectively, not only in defence, but *in covering* the last stage of an infantry *attack* upon a position, where the troops have at last to cease firing and endeavour to get home with the bayonet."

The present Gatling gun is such an improvement on the old one that there is no comparison. It is a most formidable weapon, its power of firing at any angle of elevation or depression being unrivalled.

It will be perceived that the opinions quoted are from Officers Commanding different military branches of the Service. I have got many more opinions, but I have not room to enter them in the lecture. Generals Sir Donald Stewart, Sir Frederick Roberts, General Hardinge, &c., &c., all have written to me, stating that they believe there is a great future for machine guns under certain conditions. Lord Wolseley also says that he believes there is a great future for them. Naval Officers have the highest opinion of their utility for landing, both for offensive and defensive purposes.

It would appear from these opinions, as well as from others that have been given on the question of machine guns in the field in recent lectures and otherwise, that the main point to be considered is, how they are to be mounted. It has often been said a machine gun in such and such a position would be invaluable, either by itself working

independently or attached to one of the arms of the Service; the difficulty appears to be to have them mounted in a manner to suit all the varied requirements of the cases and places where it is acknowledged they might be useful. This being so, I would suggest that there are two sorts of mounting applicable to them for service in the field; the one mounted on a galloping carriage (Fig. 8) which could accompany with ease mounted infantry, cavalry, or artillery, or work independently, or in divisions, half-batteries, or batteries; the other mounted as a weapon to accompany the infantry, as the present machine guns supplied to the Navy are (Fig. 5). I may here mention that I do not propose to enter into the question as to which of the rival machine guns is the best, but shall refer impartially to Nordenfelts, Gardners (Fig. 9), or Gatlings[1] (Figs. 6 and 7).

I will first explain what I mean by the galloping carriage (Fig. 8), which is a suggestion of my own carried into effect by Mr. Nordenfelt, (though applicable to other guns), and then propose what I hope may be considered improvements in the mounting of machine guns supplied to the Navy for landing purposes.

A machine gun mounted on a galloping carriage would bear a great resemblance to a torpedo boat, as far as the deadly and devastating power it possesses in a small compass, and the ease with which it could be transported at great speed to any position where its deadly power might retrieve a disaster or make victory certain. Like a torpedo boat there must be occasions where great risks would have to be run, but supposing it succeeds in its undertaking, it would be well worth any risk whatever. A galloping machine gun, however, has a far better chance of being able to do its destroying work than the torpedo boat, and if it should fail there is less cost in men and material. It should be capable of being instantly put into action, and by so doing act up to the theory advanced by artillerymen, that the most efficient gun is that which can go into action first and remain there the longest; it should be able to fire immediately on halting, and have as nearly as possible an all-round fire. Its mounting should be so light that horses could gallop at their top speed with it, and it should be strong enough to gallop over any rough ground, and stand the racket of a campaign as well as artillery. When needed, it is also possible to gallop up to a position, unlimber, and fire the gun under the same conditions as an ordinary field piece in action with the trail on the ground. This might be found useful on many occasions where natural cover could be found, though a very little earth thrown up would make plenty of cover for so small an object as the gun unlimbered. The carriage is so constructed that it can reverse in the narrowest lane without unlimbering. The gun mounted on the galloping carriage I have suggested, has each and all of these requirements; the gun and limber are combined in one on a four-wheeled carriage (by which means the gun is always in action, and no time is lost in unlimbering), the gun being on the rear, and ammunition boxes

[1] For full particulars of these guns, see "Nordenfelt on Machine Guns." Folio 1884; "Engineering," vol. xxxiii, page 547, and vol. xxxvii, pp. 144, 145, and pp. 352, 353, 355, to which Journal the Institution is indebted for some of the illustrations in this paper.—ED.

on the front axle." The gun is mounted so as to have an all-round fire, as its pivot allows it to train above the wheels, and so it is ready for action, and can commence firing the very instant the carriage is halted, or even while the carriage is still in motion. With a 5-barrelled Nordenfelt mounted in this way, it would be possible to gallop to a position and immediately open fire at the rate of 600 rounds a minute, or with a 10-barrelled Nordenfelt at the rate of 1,000 rounds a minute, and it can remain in a position to the last possible moment, as it is always in action, firing if need be as it retires; how useful such a gun would be for covering a retreat! Last July there was a trial at Dartford of a 5-barrelled Nordenfelt gun mounted in the manner described; it was drawn by two horses which were driven, not ridden; it fired a total of 350 rounds from seven stations during a run of two-thirds of a mile, advancing and retiring under cover against troops supposed to occupy a farm; the time occupied was 5′ 55″ including the halts, which were long enough to fire 50 rounds from each station, and the last few hundred yards of the distance was galloped up a steep hill. From the small space the gun occupied, and the light nature of itself and its carriage, which was painted grey, it was barely recognizable to the naked eye at 300 yards on the grass, so it showed practically no target, a great matter in these days of precision with war machines.

This was only an experiment, but it shows what can be done. On service such a gun, with the 10,000 rounds of ammunition with which it ought to be supplied, would require more than two horses, its total weight being 22 cwt. 0 qrs. 16 lbs.; but I will not give an opinion as to how such a weapon should be horsed or driven, as that is more an artilleryman's question than a seaman's, and I am now merely suggesting the mounting for the weapon. There is a light shield placed upon the limber or ammunition box which would protect the drivers and, to some extent, the horses when the gun is in action, as most probably their heads would be turned away from the direction of the enemy's fire when halted. A machine gun on a galloping carriage would always be more or less on the move, which would lessen the chances of its being destroyed by artillery fire.

In warfare there is nothing that has so demoralizing an effect as a sudden attack when combined with rapidity of fire; surely this effect can be obtained most certainly by a machine gun mounted on such a galloping carriage, which is equivalent to a company of infantry in its rate of fire, has greater rapidity as well as accuracy of delivery, and whose mobility must necessarily be far greater than that of a company of infantry. I recently sent a carriage of this description (with a 5-barrel Nordenfelt mounted on it) to Sir Donald Stewart in India for a trial, who had kindly offered to try it for me. I hear it has been galloped over rough ground with a pair of horses against a piece of artillery with a team of six horses, and that the trial was most satisfactory. A gun possessing the offensive and defensive power which a rifle-calibre machine gun of whatever system is acknowledged to possess, mounted in the way I suggest, might possibly commend itself to Officers of the different arms in the Service.

Weight of 5-barrel Nordenfelt complete, on the galloping carriage, with 10,000 rounds of ammunition—
22 cwt. 0 qrs. 16 lbs.

Weight of 7-pounder service gun (steel), muzzle-loading, with carriage, limber, and ammunition complete, is 25 cwt. 2 qrs. 27 lbs.

I will give a few engagements in which English troops have been fighting in late years where a machine gun mounted as described would have been of infinite service. In the Afghan war, at the battle of *Charasiab*, 6th October, 1879, nearly the whole of the infantry were employed, and necessarily the cavalry were held in reserve for the protection of the camp, thus their services during the flight of the Afghans were lost. Machine guns might have supplied the place of the cavalry for this purpose. There were two Gatling guns employed to cover the advance of the 5th Goorkhas to attack a certain hill, but they were soon put out of action by the "drums" jamming. At the Afghan attack on the *Sherpur* cantonment, 23rd December, 1879, machine guns would for this defence have been of great value, as the attacking force were obliged to pass over clear open ground in their assaults. The weak part of the defence between the field hospital and the Behmaru village could have been greatly strengthened by machine guns. At *Ahmed Khel*, 19th April, 1880, a large force of Ghazis made a furious attack on our troops whilst in the act of forming up, which nearly ended most disastrously. Machine guns, nerveless, and with great rapidity of fire, would have checked or repulsed the rush of the Ghazis, the last 300 yards of rush being over open ground. At *Maiwand*, later on, if machine guns had been used in place of the six smooth-bores, the result of this affair would have been materially altered, by reason of their power to stop rushes of men, and by their not suffering from the effect of demoralization.

The Zulu War afforded a splendid opportunity for the employment of rifle-calibre machine guns having great *portability*, certainty of action, &c., as the Zulus attacked in masses, and the ground was generally open and favourable to such fire. In the assault, and subsequent destruction of our camp at *Isandwhlana*, these guns must have proved invaluable, as there was time afforded to temporarily entrench them, even if not placed within the laager. The defence of *Rorke's Drift*, and the massacre at the *Intombi* River, might have had different results with the assistance of such guns. At *Ulundi*, machine guns *that could have rapidly and easily moved from point to point* of the square as the attack developed itself, would have been of great assistance in addition to the Gatlings used there. At *Majuba Hill* in the Transvaal two machine guns would have been the means of checking and repulsing the final fatal rush of the Boers, had the guns been light and portable enough to have been carried up the hill.

I will now turn to the mounting of the machine guns as supplied to the Navy for landing purposes. With this gun (as with the galloping gun I have mentioned), to be thoroughly effective, it should always be ready, that is, always in action. Limbering and unlimbering does away with much of its utility as a machine gun, the limber adds to its weight, it is not ready for instant action, and the fact of having to unlimber hurriedly must tend to make the men unsteady, especially if

under fire. Absolute steadiness and perfect self-control is essential for the success of machine gun fire. Another weak point in the Service fitting is the fact of having to lift the trail of the gun by order "Trail right" or "Trail left," to get the training on. This takes time, and throws the elevation out. A machine gun should be able to get its training on in nearly every direction, without touching the trail, and to do this it should be pivoted on the axle, so as to enable it to train above the wheels.

In support of this argument I may quote from a letter I received from Admiral Sir William Hewett, relative to the machine gun mounting: "At the battle of El Teb," he says, "the Gardners belonging to the 'Sphinx' were fitted to the 7-pounder gun carriages with a plate; this brought the machine gun clear of the wheel, and a man could turn the fire round without moving the gun carriage; in fact, no trail training. The Chief Engineer of the 'Sphinx' fitted their machine guns in this way, and they were a great improvement on the service fitting, of which we had one belonging to the 'Monarch.' This carriage did not allow the gun to train all round, so it was the old thing of right or left; besides, with those fitted high the barrel was just up to a man's shoulder." Commander Rolfe, who commanded the Naval Brigade in the Soudan, also writes me: "The service mounting of the Gardner is open to a good deal of criticism; it is too low, and the gun has to be trained by the trail instead of the screw. It is most necessary to be able to fine train; and when it is considered that it is the most delicate rifle fire, you cannot have your training screw too fine."

It would be better to do away with the limber altogether for the Naval gun mounted for landing purposes. It is far too heavy, making a vast amount of unnecessary weight for the men to drag, and the gun being limbered up prevents it being always in action, which detracts from its value as a machine gun. There is everything to say against it, and nothing to say in its favour. Men, horses, or mules could easily carry the ammunition for the guns, and they would be far more efficient if this were done; the wheels of the present carriage are not large enough in diameter, neither are the tires wide enough. I will here read a letter received from Captain Wilson, V.C., which bears out in many particulars the remarks made on these matters, and gives some excellent suggestions founded upon actual experience in the late fighting in the Soudan. "At El Teb the whole advance was necessarily made in fighting formation. The square was expected to be able to withstand a rush at any moment; a team of animals under these circumstances would have been very unsuitable; even with men the space required for reversing the limbers entailed considerable gaps in the square, which had to be rectified afterwards; but with animals these gaps would have been much larger, and the time occupied much greater. In either case the operation of unlimbering and coming into action is attended with a certain amount of confusion at a moment when the most perfect order is required; when the square halted at 900 yards from the enemy's position, the practice from the Gardner gun of the left half-battery which then came into action was admirable.

The practice at this period I look on as illustrating one of the best uses of machine guns. The whole square lying down, that is under the best cover that the circumstances admitted of, not a single man wasted a cartridge, and the machine gun quietly delivered a fire under the most perfect control, which must at that range have been equivalent as regards actual effect to the fire of not less than 100 marksmen. As soon as the advance against the enemy's works was commenced, the defects of our present system of mounting at once became apparent. The left half-battery then formed the right of the leading face of the square. To advance it was necessary to limber up, and this not only prevented them from firing, but what was worse, it made what was practically a gap in the front of the square. A rush of Arabs when they were close up to the enemy's guns showed very distinctly the danger of this arrangement, as it compelled the guns to come into action in a hurry just when a steady front was required. Fortunately the number of Arabs was small at that point, or the position might have been an awkward one. The necessity for ever limbering up a machine gun in action appears to me to be fatal to its efficient use. It is bad enough with artillery, whose work ends at about the ranges where that of rifles and machine guns begins. With weapons that are expected to fight at close quarters the system is quite inadmissible. I strongly recommend doing away with the limber entirely, using pack animals or men to carry the ammunition, and making the gun always travel independently. The weight of the limber for the 5-barrelled Gardner gun packed is 6 cwt. 2 qrs. 3 lbs., while that of the gun and carriage with feeder filled is 6 cwt. 0 qrs. 23 lbs. Doing away with the limber therefore saves half the weight to be dragged, and the weight will run easier on two wheels than on four. The actual weight of ammunition and holders carried in the limber is only 1 cwt. 3 qrs. 25 lbs. (say 2 cwt.), so that the empty limber weighs more than twice as much as the ammunition it can carry. To have a cart weighing more than twice as much as its load must be a mistake, especially when it is expected to travel over rough ground. Two pack mules could easily carry the 1,200 rounds which the limber contains. Suitable panniers should be made to strap on to an ordinary pack saddle, each pannier fitted to take six holders containing 50 cartridges each. I should make them in three divisions for strength, each division to take two holders, which should have handles on the top to lift them out by. It should not be necessary to take off the panniers to get at the holders, but they should be easily removable, to save the animals during halts. The weight of each holder filled is 9 lbs., so each mule load would be 108 lbs. plus the weight of panniers and pack saddle. A mule can easily carry 160 lbs., exclusive of saddle, so there is a considerable margin left.

"To make the gun travel easily by itself, I should propose to take off the present trail and substitute two stout shafts, thus making the carriage simply a two-wheeled cart without any body. In the firing position the shafts would rest on the ground, and although on rough ground only one would be generally touching the ground, I think that would be enough to steady the gun, as there is no recoil. The wheels

should also be made a foot larger in diameter than they are at present, and the tires at least an inch wider.

"In action the gun should always advance muzzle first, two men on each shaft pushing, and two men on each side with short drag ropes pulling; the feeder always on the gun. It is then instantly ready for action by merely dropping the shafts. On a long march, when not liable to surprise, a single mule or horse may be put into the shafts, and the gun may travel breech first; or if there are no animals, the covering party, which I think should always be with the gun, should take half-hour spells at the drag ropes.

"The disadvantages of being caught limbered up, as I have described, were evidently felt, as the guns did not attempt to limber up again during the remainder of the action.

"I was much impressed with the ease with which the fire of these guns could be directed or controlled by the Officer in command, in comparison with the rifle fire of both soldiers and blue-jackets. The men were at this time very excited, the noise and general confusion preventing orders from being heard; mounted Officers rode furiously up and down the line with little effect, while the bugles almost continually sounding 'cease firing' seemed only to add to the noise; but the machine guns were under perfect control. Orders quietly given to 'search out that clump of bush,' 'keep your gun bearing on that corner of the wall,' or 'cease firing till they show again,' &c., were carried out with the greatest regularity.

"Each machine gun should have its own covering party, as it cannot defend itself at close quarters. On this occasion their own guns' crews were split in half, one half being with the limbers, and the rest with the guns, and they were swept away with much greater ease than if each gun had had a compact party specially told off to defend it. . . . . While the gun is encumbered with a limber you cannot make it conform to all the movements of a company, and it would only create confusion to attempt it; but with the gun alone, fitted as I propose, I think it could be done with ease and with great effect."

I will now refer to the question of ammunition. It should be imperative that every rifle-calibre machine gun supplied to either Service should throw the same ammunition as the Service rifles; unless this is done, endless and needless trouble and confusion may arise on a campaign, and indeed a fearful disaster might occur, as these remarks of Commander Rolfe to myself exemplify. Commander Rolfe says: "When we got to Tokai I sent back for a further supply of ammunition, which came up by convoy, but I found one box short. As I was walking about the camp I found an empty box of Gatling cartridges in one of the regimental lines; knowing that no infantry regiment had any business with such a box, I went to the Commanding Officer and told him that I thought he had got some machine gun ammunition. On the pouches being examined, nearly all my missing cartridges were found. The result of this comparatively harmless peculation might have been most serious, as you can get the machine gun cartridge *into* a rifle, but it's an awful job to extract the empty cartridge.

"Such a mixture of ammunition might in this instance have resulted in practically spiking every rifle in a regiment, and caused a panic."

The machine guns which I sent to India last spring for trial all fired the Martini-Henry Boxer cartridge without any trouble from jamming, feeding, or extracting.

That the machine guns of the present day are accurate, rapid in their fire, and terrible in their man-killing power is beyond doubt; whether they can or cannot be better utilized for the Services is a grave question for consideration. For Volunteers they would appear admirably adapted, and the London corps under Colonel Alt have lately demonstrated (as far as drill can do, and in the recent sham fight at Portsmouth) how exceedingly useful they might be. Artillery Officers as a rule are supposed not to look upon them with favour, but most of the arguments used against them appear to treat them as guns instead of clusters of rifles, which they really are. I have endeavoured in this paper not to obtrude my opinions too strongly on a question which is more perhaps of a military character than a naval one. Confidence in the immediate future of these guns induced me to read it, and it would have been impossible to have approached the subject without trespassing slightly on military ground.

Experimental Field Firing at 7 *Screen Targets,* 18 *ft.* × 6 *ft., in column, at* 1,200 *yards range.*

Comparative effect of the Nordenfelt gun, No. 2 *mountain battery, and* 150 *rank and file, in four minutes.*

Nordenfelt 10-barrel Machine Gun.	No. 2 Mountain Battery. Four 7-pr. Guns.	150 Rank and File, 4th King's Own Regiment.
No. of rounds fired.. 1,596 Total No. of hits .. 250 Average, 1 hit in 6·38 shots, or 15·7 per cent. The Nordenfelt fired for 2 minutes, halted for 2 minutes, then fired again for 2 minutes.	No. of rounds fired, shrapnel (containing 2,058 bullets) 49 Total No. of hits .. 182 Average, 1 hit in 11·3 bullets, or 8·85 per cent. The Mountain Battery fired continuously for 4 minutes.	No. of rounds fired 3,967 Total No. of hits .. 547 Average, 1 hit in 7·25 shots, or 13·8 per cent. The infantry fired for 2 minutes, halted 2 minutes, then fired again for 2 minutes. The men elected for independent firing.

Poona, 14th March, 1884.

The CHAIRMAN: I think that we are bound gratefully to recognize the moderation of tone, I might almost say the gentleness, with which our lecturer has introduced a subject generally supposed to bristle with so many dangers of offence to the susceptibilities of the various arms. I hope that in discussing the questions involved we may adopt the same course. He has put forward various weighty statements of fact, certain interesting opinions, and some very practical suggestions. On any or all of these, for or against, your comments are invited. I think, however, it would be desirable that we should see a little of the working of these machines before the discussion commences.

Fig. 4.

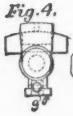


Fig. 5.

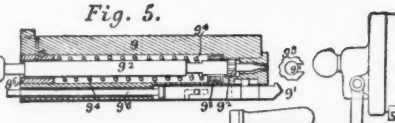


Fig. 3.

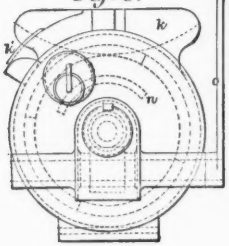


Fig. 6.

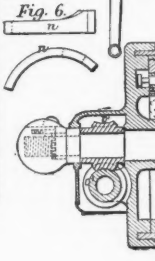


Fig 8.

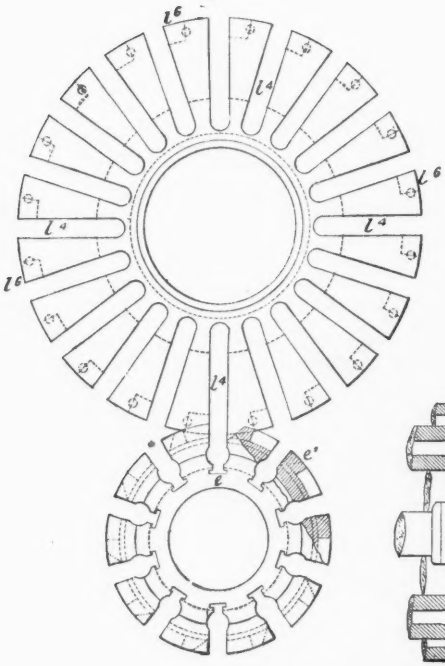
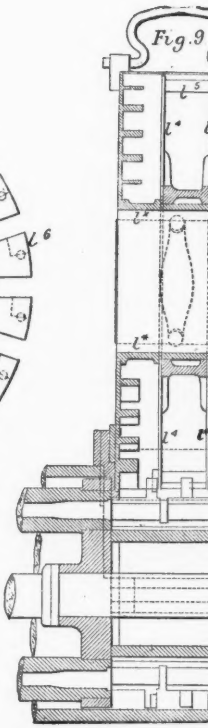


Fig. 9



APPENDIX.

DETAILS OF THE NEW GATLING GUN.

Fig. 1.

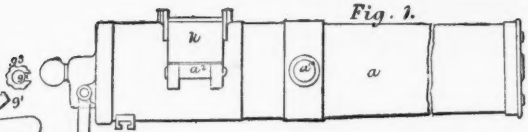


Fig. 2.

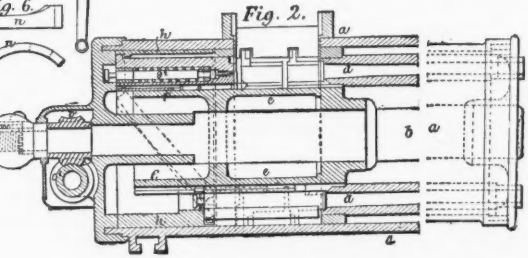


Fig. 9

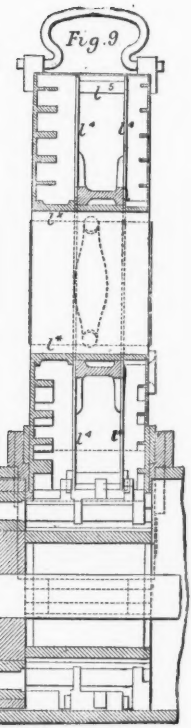


Fig 10

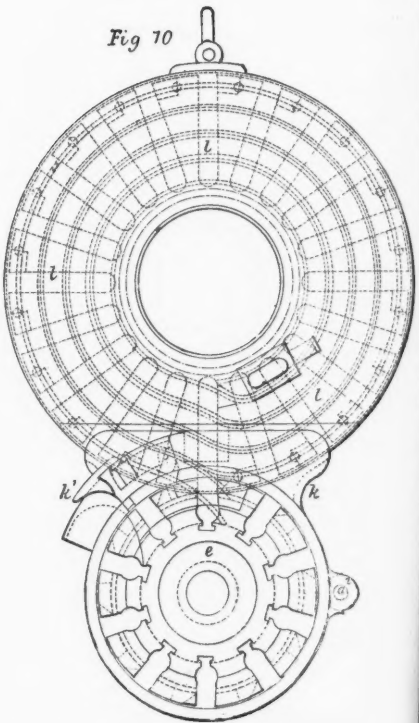
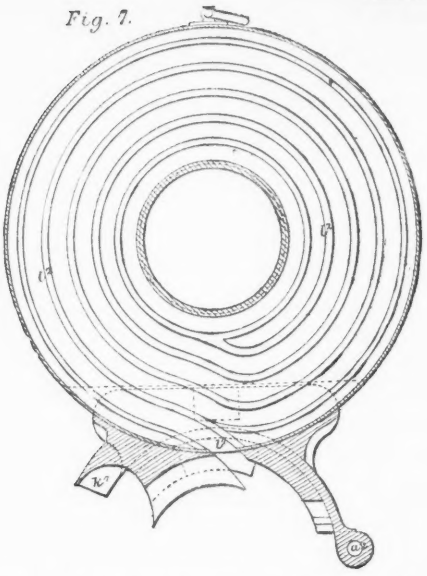


Fig. 7.



These weapons have six, eight, and ten barrels, each being provided with its corresponding lock. The barrels and locks revolve together inside an outer stationary case, but in addition to this the locks have an independent forward and backward motion. The former places the cartridges in the chambers of the barrels and closes the breech at each discharge, while the latter extracts the empty cartridge case after firing. The cartridges are supplied to the gun from magazines consisting of a circular drum of a width slightly greater than the length of the cartridge. The magazines hold from 65 to 104 cartridges each, and weigh from 10 lbs. to 24½ lbs. when full of cartridges. The musket-calibre guns weigh from 100 lbs. to 237 lbs. each, according to the number and length of the barrels.

Fig. 1 is a side elevation of the gun, Fig. 2 is a longitudinal section through the axis, Fig. 3 an end view, and Figs. 4, 5, and 6 details of the bolts and extractors. The outer case *a* incloses the group of barrels *d*, which are spaced around the central axis *b*. At the rear a worm b^1 is fixed on it. This is rotated by means of the wormwheel e^1, which is operated by a crank handle shown in the general view. The receiver for the cartridge is shown at *c*, and *f* is a chamber in one piece with it, into which the sliding bolts *g g* are drawn back. These bolts are actuated by cams formed on the ring *h* placed within the casing *a*. The ring is stationary, but the barrels *d*, the receiver *e*, and the cylinders *f* are carried round together by the crank. The magazine is placed on the casing over the opening in the receiver, being held in place by a spring catch k^1. Figs. 7, 8, 9, and 10 are views of the magazine in place and its relative position to the receiver and the mechanism of the gun. The cartridges descend from the magazine and hopper into the receiver, and the projections e^1 upon this latter serve to give motion to the propeller of the feeder; the motion of the cartridge till it reaches its proper compartment is controlled by inclines, corresponding with the channels in which the cartridges are guided within the feeder. The spiral ribs on the faces of the feeding drums are shown at l^2, and l^4 are radial slots formed in the side plates of the propeller; in these the bodies of the cartridges lie. The teeth l^6 on the propeller, gear into the projection e^1 of the receiver, the result being that the cartridges are brought forward at the proper moment. The magazine is charged from an opening in the side, as shown.

Mr. GEORGE ACCLES then explained the working of the new Gatling gun, which he stated had many improvements on the old Gatling, both in reference to the feed and extractors. He explained the construction of the magazine, and stated that for use on board ship the crank of the gun was placed at the side, so that one man by means of the pointing lever could direct and fire the gun at the same time. For field service, the gun was mounted so as to give an all-round fire, and for high angle or mortar fire about 50 degrees of elevation could be obtained, which would give a range of 1,800 yards. For all elevations above 60 degrees a hole could be made in the ground and the trail inserted. In this way he had frequently fired the gun at 88 degrees of elevation, which gave a range of 200 yards and a penetration of 2 inches of pine wood. In the same way the gun could be depressed so as to fire down from ships' tops, or from the tops of houses. If they were firing at an unknown range, say for instance at a distance judged to be 2,000 yards, the stop could be set in a way that in firing the gun they would cover a space of 400 yards. He might perhaps be allowed to explain that the Gatling gun would not be put out of action by any of the barrels or locks being damaged, as the lock could in two seconds be removed and the firing continued. There were no more movements required to fire a cartridge in the Gatling gun than in any other machine gun; every machine gun must receive the cartridge from the magazine, put it into the barrel, fire it off, extract the empty shell, and eject it from the gun. The Gatling gun did exactly the same, only it did not do it in the same way, as it fired one shot at a time in rapid succession, while the Nordenfelt gun fires in volleys.

Mr. NORDENFELT explained the construction of the gun carriage made to Lord Charles Beresford's suggestion, which he had exhibited. He said the gun was fitted with a spreading action, and fired five shots at each motion of the crank. The cartridge boxes contained 50 rounds each, and two men were employed to work the gun, one to aim and fire and the other to feed. When the gun carriage was moved quickly from one part of the field to another, it was always ready to fire without unlimbering, the man being ready to aim and fire, his two lines of sight on the gun enabling him to aim along the side of the gun from which the smoke blows away. The limber carried from 6,000 to 8,000 rounds.

Mr. GARDNER also explained his gun. He said there was nothing to show since the Committee had examined it. There was, however, one feature about the gun which he should like them to see, and that was the convenience of taking it to pieces.

Admiral BOYS: You have been kind enough to call upon me, Sir, to open the discussion, otherwise I should not have risen, and I have now but little to say. Lord Charles Beresford has invited criticism, but I scarcely see that there is anything to criticize. I agree generally with the opinions that he has expressed upon the question of machine guns in the Navy, and as to the land service he has mostly quoted the opinions of other people, expressing his own views very moderately, and I must also agree with him there. The paper deals chiefly with the 5 and 10-barrelled machine guns, and the smaller 2 and 3-barrelled guns are not referred to. Now I think myself, from a naval point of view, and so far as I can judge for service on shore, that lighter guns and fewer barrels would give a sufficiently numerous fire for the defence of posts and in many other positions. If we can with a 2 or 3-barrelled gun obtain as many as 200 or 300 rounds a minute, I do not think we want a more rapid fire, and for one reason especially, that the question of the supply of ammunition becomes very difficult. It is certainly a *sine quâ non* that the ammunition for these small machine-rifled guns should be the same as is used for the service rifles. I have nothing further to add except to thank Lord Charles Beresford for his instructive lecture.

Captain COLOMB, R.N.: I think, Sir, really this is a military question, and I think the noble and gallant lecturer has invited military criticism. You have called upon me, and of course I shall respond, but I would very much rather have heard the opinions of competent military men than those of what I may call—speaking personally—incompetent naval Officers, that is, as far as this particular subject which we have to consider is concerned. I think the lecturer has done good public service; I am sure we in the navy think so, because we are all of us convinced, I think to a man, that the age of the machine gun is just beginning, and that we do

not at all know how far we can carry it; and we think the sister Service is not as fully alive to the importance of the weapon as we of the navy believe it should be. There is one great advantage in a paper of this kind over some papers that we have in this Institution, namely, that it is not, so to speak, academical; it is a real paper, treating of wants which are close to us, and of circumstances with which we may have at any moment to deal; because that nation which, by land or sea, most appreciates the advance and improvement in weapons, is the nation which wins in the first onset of war. And it behoves us, with our small army, especially in these times, to turn our attention to how we can economize our men as regards their power. Admiral Boys has spoken upon a part of the subject on which I also think strongly, if I may be allowed to think strongly on a question which is so purely military. I think the guns with a smaller number of barrels are not receiving the attention which they deserve. If we look before us, we see the mass of weight which has to be carried about to convey these five barrels into action. We have seen this 2-barrelled gun (Gardner) taken to pieces by a single man, and it could, of course, be carried about by three or four men. But even that double-barrelled gun I consider too heavy a weapon for ordinary service in the navy; I prefer myself the single barrel. I have seen Mr. Gardner's single barrel, and have fired a very large number of rounds with it, and I have always estimated, taking it side by side with practised rifle marksmen, that that gun was equal to 8 rifles. I have always understood in my reading that the great difficulty in warfare on land is not so much to carry the firing apparatus into action, as to provide it with the necessary ammunition. Now if you could carry a single-barrel machine into action with two men, as you undoubtedly can, you immediately release 6 men to provide that gun with ammunition; I am not going to say how far they would carry it; I am not going to say whether a gun of that sort could be employed in skirmishing, but I cannot help thinking that two blue-jackets, one carrying the gun and the other carrying the tripod, with six blue-jackets bringing up the ammunition, would after all be as formidable a force as the same number of riflemen, and of course as the ammunition would be superabundant, I should take it that some of these six that would carry the ammunition might be taken off to act as riflemen, if necessary, for the protection of the gun itself. That is the chief point I wish to make with regard to machine guns. I am very strong also upon having the same ammunition for rifles as for machine guns; I think it is of all things the most important matter, and I have said before in this Institution that I think we made a serious mistake when we attempted for a moment the use of special ammunition for our new machine guns. I found, even with the old Gatling, that it would fire the ordinary rifle ammunition, not well, but still it would fire it, and the 2-barrelled Gardner and the single-barrelled Gardner I found would fire the rifle ammunition especially well. True there was a jam now and then, but they were not difficult to clear and did not occupy much time. While I say all this to you about the gun having a small number of barrels not being so much brought to the front as it ought to be, everybody must admit the general positions of the lecturer, and those exceedingly valuable opinions which he has quoted in support of them. I do not attack in any way these larger batteries, so to call them; I think each kind of machine gun will have its proper place in time of war, and I think the lecturer deserves our thanks and the gratitude of the nation for pointing out the absolute necessity of considering this question.

Captain LEWIS, R.E.: What I was thinking of saying has been taken out of my mouth by Captain Colomb, for it would be in support of the 1-barrelled Gardner, a gun with the smallest possible number of barrels, which is consequently so very light and easy to handle. I have had no practical experience with the gun in the field, and the lecturer brings forward instances in which no doubt the larger number of barrels were very useful, when perhaps a small number would not have been equally so; but there are many cases in mountain warfare, the defence of positions, and so on, in which I think the single-barrelled gun would be found more handy to manipulate, and be sufficiently rapid in use. In the defence of villages the single barrel will be very much more easily manipulated. It can be fired through a small loop-hole, and it can be carried into places where a wheeled vehicle could not go. A certain proportion of ammunition could be carried with it on a single mule; in that

way it would do for mountain warfare, and for short distances the men who worked the gun could carry it. I believe Mr. Nordenfelt has brought out even a lighter gun than the Gardner, but I have had no practical experience of it. Of course if it is lighter, and fires equally well, it would be better.

Colonel ARBUTHNOT, R.A.: I had not intended to take any part in this discussion because I know there are so many Officers here who are better able to discuss it than I am. My only object in rising is with regard to a remark made by Admiral Boys and Captain Colomb as to the great necessity for having the same ammunition for the machine guns as for the rifles. In the new rifle about to be adopted, I hope, in the army, that question has been considered, and the new cartridge to be fired from the new rifle has been devised of such a length as can be used for any of the existing rifle-calibre machine guns without any other alteration being necessary than the substitution of a barrel of a smaller bore, so that when the new rifle is introduced the only alteration required in the machine gun will be to substitute the smaller barrel, and then they will fire the same ammunition as the rifles. There is one question with regard to machine guns which I do not think is sufficiently considered, and that is the question of mounting a gun on shore. By the end of this year there will be upwards of 600 rifle-calibre machine guns in the naval service, and for those 600 guns there are only 24 carriages to take them on shore. This question, if I may venture to say so, is very much overlooked by the Admiralty, because we all know that in all our wars sailors take a very prominent part, and wherever we have to fight, we are always glad to have blue-jackets helping us with their field guns and their machine guns. In the late war in the Soudan the only guns taken to the front were the machine guns. When the war was beginning everybody was trying to find carriages for Gardner guns, and it is only since that campaign has taken place that the question of mounting these guns has been at all considered. The only carriage that exists for taking the guns on shore is the converted Gatling carriage, which has very small wheels, and is very inconvenient in many other ways. I have been asked to devise a carriage for these guns, and I have asked to have a naval Officer associated with me in getting up a mounting suitable for the requirements of the service, and if the Admiralty will put such an Officer in communication with me, I shall be very happy to consult with him. I think, seeing that we have so many brains now at work on this question of gun-carriage, we ought to be able to devise something really efficient, and when there is a good mounting for the machine gun, I have no doubt the military element will take it up as a land weapon. I do not pretend to know anything about tactics, and will therefore leave that to be handled by abler hands than mine.

Major ROGERS: I wish to congratulate my friend Mr. Nordenfelt, and all those interested in the machine gun question, on having the able advocacy of Lord Charles Beresford on this question. Last year he read a paper on the same subject treated from a naval point of view, and I am very glad to say that paper has borne fruit, as I prophesied it would. Since then an opportunity has occurred for the employment of machine guns in the field, but, so far as the Gatling gun is concerned, those actions in the Soudan furnish no just estimate of the effect of perfected machine guns. Lord Charles Beresford referred to the difference between the old and the new Gatling; the difference is this, that in the new gun the feed is what is technically termed "positive," that is, the ammunition is under control of the mechanism from the moment it is placed in the feed until the cartridge is fired and the case extracted. The gun therefore can be fired at all angles of elevation or depression. In Lord Charles Beresford's lecture you have heard an instance quoted where a Nordenfelt gun, fired at a range of 1,700 yards, dropped 293 bullets out of 300 within a space of 100 yards by 50. Now, as an old instructor of musketry, I should understand that this performance was merely due to the trajectory of the bullets, and not to any special mode of elevation in the gun; but with this new Gatling one can fire with positive certainty at any degree of elevation, and drop bullets behind entrenchments, or behind walls or buildings, at any range between 200 and 3,000 yards. Now as regards the carriage which I see before me, I have in my hand a sketch of a carriage mounting of a similar nature; but Mr. Nordenfelt's has four wheels. This one to which I refer was used by the United States Cavalry in their warfare with frontier Indians, the short-barrel

Gatlings being simply mounted on a two-wheeled cart, which also carries the ammunition.[1] I think such a carriage would be more handy in the field than the one I see before me, which is almost as large and cumbrous as any field-gun carriage. As regards machine guns being given to Volunteers, I am quite sure that this would be a most popular movement. A few years ago I had the pleasure of instructing some Artillery Volunteers at Chester in Gatling gun drill, and the interest shown by them on that occasion proved to me that if a couple of guns were issued to each administrative battalion of Volunteers, such a movement would be most popular. Among Volunteers there are many skilled mechanics, and, let people say what they will, I think it would be a great advantage to employ skilled men to manipulate these somewhat delicate weapons.

The CHAIRMAN: There are times and occasions on which the machine gun in the field has not as yet approved itself quite a success. We have an Officer present who was in the last battle in the Soudan, when the machine guns underwent considerable disaster. Possibly Colonel Holley may give us some light on the circumstances of that particular occurrence, which was so grievous, although so glorious, to some few.

Lieutenant-Colonel HOLLEY, R.A.: I did not come here, Sir, to make observations on this paper, and am therefore quite unprepared to join in this discussion. I had the honour to command a 4-gun battery at the battle of Tamai. We marched out from Suakim with the Naval Brigade, and I have never witnessed such a sight as the sailors drawing their machine guns. The pluck they showed and the work and labour required to drag those guns along for more than 20 miles was very great. I am sure if one had not seen it one would not have believed it. I think it is quite time that some carriage should be adopted, and that either mules or horses should always be used to draw machine guns. The advance of these guns for any distance should certainly not be left to manual labour. I must say I think the machine gun, as far as my experience goes, should have a special corps. A short time ago I was at Bangalore with Sir Frederick Roberts, and three machine guns when there tested came to grief. The three guns were working at one time, and on the second trial only one gun was able to keep on firing. General Smythe has asked me to refer to the machine guns at Tamai. I do not think they had fair play there; they were dragged on to the edge of a ravine close to the enemy, and could not be fired at any but a very short range. There is one point which has struck me during the lecture, and that is the reversing of these guns. In my battery in the Soudan I had nearly all my ammunition on pack mules; of course those mules are difficult to manage; but what I want to say about the machine gun is, that if you have them in a square as in the Soudan, there is no occasion to reverse; the gun is such a light thing that you can easily unlimber and run it up by hand to the edge of the square, and cause no confusion in the square by leaving the limber where it is. I do not think there is any other observation which I wish to make.

Lord CHELMSFORD: I do not like to allow this discussion to close without as an infantry Officer expressing my opinion on the subject, more especially as Lord Charles Beresford has done me the honour to quote an opinion of mine in his paper. I think we are all very much indebted to him for having opened out this very important question; I feel sure that the discussion of to-day will be of infinite service to

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[1] I read to the meeting a description of this magazine carriage as follows:—"50 short-barrelled Gatlings have been issued for service with the United States Cavalry. Each gun is mounted on a light two-wheeled cart, so constructed as to answer the double purpose of an ammunition wagon. The cartridge boxes on either side of the gun contain together 40 feed cases, each holding 40 rounds, or 1,600 cartridges in all. Space is also reserved in front of the axle for two boxes of cartridges, containing 1,000 each, so that the carriage can take with it a large supply of ammunition as well as the gun and a few necessary tools." The above quotation and accompanying sketch will be found in vol. xix of this Journal, in a paper read by me on the 19th April, 1875, entitled "The Gatling Gun; its Place in Tactics." The mounting of this *galloping Gatling* should, however, be pivoted clear of the wheels so as to command an all-round fire.—E. ROGERS.

the army at large, because whilst it has been shown that machine guns are capable of very great development, it is clear that that development has not at the present moment received much encouragement from military authorities. The carriages are no doubt an extreme difficulty, and before we devise the carriage, we ought to come to some definite conclusion as to the manner in which the machine gun is to be worked by the different arms of the Service. If they are to be worked as the Colonel of an infantry regiment suggests (and I am not prepared to say his views are unsound) with cavalry, then no doubt something like the horse artillery gun carriage devised by Lord Charles Beresford must be used. The idea which this Officer has suggested had not occurred to me before, and I think perhaps it is more an artillery question than one of general tactics. It seems to me that for cavalry acting against cavalry if machine guns are to be worked so effectively as this Officer states they can be, then it appears to me (I say this with all deference to the opinions of artillerymen present) that it would be advisable to let them take the place of horse artillery guns altogether for this particular duty, as the machine gun firing upon cavalry would produce more effect than the ordinary artillery projectiles. This is an important question, which could be settled satisfactorily by a joint Committee of artillery and cavalry Officers. With regard to the employment of Gatling guns with infantry, they might be of immense value, assuming that they can be brought into action without undue fatigue to those who have charge of them. I see no reason why one of these guns should not be drawn by a single animal, supplemented of course by drag ropes when occasion requires it. They might be of immense value to infantry both in defence and attack. In defence they would be invaluable at the last stage of an attack, when artillery fire is, comparatively speaking, of little use. These machine guns would in fact take the place of case-shot, which has almost disappeared as an artillery projectile, and at that critical moment when the enemy has advanced within charging distance, a certain number of machine guns placed along the line would materially increase the difficulty of that last stage of the attack. As regards the employment of machine guns in an attack, I have just pointed out that the critical moment is when the infantry must cease firing and endeavour to charge home—any assistance which the defence can get at such a time would be absolutely invaluable. I do not see any reason why these machine guns should not be able to give that assistance if their vertical fire at a *very high angle of elevation* is of such an effective character as has been stated. If this be really correct, then a certain number of machine guns, at a distance we will say of 1,000 or 800 yards, in a position where they would be practically sheltered from artillery fire, would be able to fire without any fear of hurting the infantry, and drop their bullets in enormous numbers into the enemy's front line of defence, and thus materially assist the attacking lines at the critical stage. Those are the only ideas which occur to me with regard to the lecture. I think we are very much indebted to Lord Charles Beresford for bringing this important subject to notice, and I sincerely trust that the difficult problem will be worked out by those who are thoroughly capable of solving it satisfactorily.

Mr. NORDENFELT: I shall carefully avoid any comparison between these several systems of guns, and will draw attention simply to the mountings. Lord Charles Beresford's carriage is for the purpose of using the gun on flats in the field, where you can put two or four horses to it, and make certain that the gun can follow any cavalry or artillery. The next type of carriage is one which may be drawn by one horse, with assistance from men with drag ropes, or carried on mule back or otherwise pulled along the ground, for which purpose you want a smaller carriage. The third example is a light gun on a very small carriage, so light that a man can take it on his shoulder. It strikes me that you cannot compare one with the other: there are three distinct objects and three distinct guns wanting, three different distinct mountings and modes of carrying ammunition. According to my view you will want them all three sooner or later. Lord Charles Beresford's carriage is made to solve one of the points; the other carriage is made to solve the others. This leads me to *the question of the number of barrels*. I admit that 300 or 400 rounds per minute is quite enough for any practical purpose, but 300 or 400 rounds in battle cannot be relied upon from my 3-barrelled gun, nor from the Gardner 2-barrelled gun, probably not even from the 5-barrelled guns of either

system. In battle you are often firing at moving bodies of men, and must aim between every certain number of volleys or shots, and I am willing to admit that with a 10-barrelled gun for instance, be it Dr. Gatling's or my own, supposing we fire 1,000 rounds at full speed, I do not think that we would fire more than about 200 to 300 rounds against moving objects in actual battle; therefore at that rate a 2-barrelled gun would only fire about 80 to 100 rounds a minute, and that we all consider too little for a machine gun in action. I consider that in battle you are bound to have a gun which in a certain given few seconds can fire the greatest number of shots, and which is not too heavy for the work it has to do. For instance, if you want to fire off in each volley as many as possible and no more, you do not want to spin away for about half a minute, because during that time your enemy has gone and you are obliged to follow him; that is the reason why for field use you most certainly ought to have the very greatest number of barrels in a gun that the weight for that special purpose can possibly allow, because even then I do not believe you will fire more than 300 or 400 rounds a minute. *I do not believe that machine guns will waste ammunition;* I believe the number of shots fired per number of hits by infantry must be considerably larger than in machine guns. It is not because an infantry man does not fire as well as a machine gunner would, except that of course a machine gun is fired from a fixed rest, but because a machine gun in the course of war would not be used morning, noon, and night like infantry; perhaps you would not want it for a week or a fortnight, and then you might require it for five minutes in a position in which it would be simply invaluable. And then no ammunition fired could be wasted, because a machine gun does not fire against a facing line of skirmishers, it fires against a mass of men so as to get a fair field for hitting. If you sat down to fire against skirmishers at 800 yards, you would not get a large percentage of hits, but if you fired against a column, or line, or a cavalry squadron, you would get a greater percentage of hits from machine guns, and very much greater than statistics show that you have ever got from rifles taking them all round. I was asked this morning whether I really seriously thought that a General would prefer a battery of machine guns to a regiment of infantry; of course the question was put in play, and I answered it in play. Of course I do not believe that, but I fully believe that any General on being asked whether he would prefer four infantry regiments with machine guns or four regiments without machine guns, would not hesitate for a moment to take those with the machine guns. I do not look upon the machine gun as replacing a single rifle or gun, it has nothing to do with them; but a machine gun is a most valuable additional weapon. There seems to have been an idea at one time that artillerymen objected to machine guns: I do not think they do; they only wish the General and staff to decide who is to have them. The artillery do not want them themselves, but they do not object to their employment by other branches of the Service. It must be the same in an army as in anything else all through the world: anything that adds to efficiency generally does not detract from the efficiency of other useful weapons, it adds to their efficiency, and more are required of them. I am very pleased to see how quickly this machine gun work has developed in the last year or two. Five or six years ago when I first came to London with machine guns, I was thanked for showing the "very pretty things," but I was asked, "Surely you do not expect the English army to think of adopting anything of that kind?" To-day I find the machine gun question is the subject of a Prize Essay for the Royal Artillery Institution, and is looked at seriously by everybody interested in the defence of the country. When we manufacturers have done what we can, it remains for the intelligent Officers of the army to take up the question. I do not think that one Service need wait for another, because I believe at the end they are bound to find use for them; and I believe that the English army is more especially a suitable field for making a start in this matter, because every time that I have read of any fight or any trouble with the English army since I began to be able to read, it has never been 200,000 Englishmen who have been fighting 200,000 other people, but it has been about 500 Englishmen who have had to fight at least 10,000 other people; and for that special reason, for the small wars you have abroad, I cannot imagine how it is possible, after the subject has been really ventilated, that you can avoid having machine guns. Then and only then will you be able to find out how they can be best equipped and organized, and who is to

organize the machine gun as a weapon of the army, and I believe that when you once set to work you will very soon come to good useful practical results.

Captain JOHNSTONE, R.N.: I would ask if the lecturer can give us any practical information as to how much ammunition was expended in the Soudan, whether the amount was excessive or not.

Lord Charles BERESFORD: I am very sorry I cannot give that information; it was not contained in the letters which I received only a fortnight ago.

Captain ARMIT, 22nd Middx. R. Vols., late R.N.: My only excuse for rising is, first, that I have seen the mitrailleuse actually at work on the field of battle during the Franco-German war, and can confirm every word that Lord Charles Beresford has said with regard to the use of these guns; and, secondly, that I have commanded two machine guns for the last two and a half years, and therefore I had the presumption to think that my experience might interest some of you. With regard to the Franco-German war, I was present at most of the actions, in connection with the Volunteer Ambulance, and had good opportunity of seeing what was done; and I can assure you the Prussians went into that war terribly afraid of the mitrailleuse; but after the first two or three actions they were very much surprised to find the guns did not do what was reported of them at first. When they were taken, we found out the reason. The Officers and men set to man these guns had actually had no drill whatever; they were utterly untrained men, and knew no more how to use these guns than a second class boy would know how to handle a revolver. I asked them why they had not drilled their men, and the Officers confessed they did not know anything at all about it; they did not even know, in many cases, how to open the breech. I remember at Sedan a Sergeant-Major of a battery came up to me and said he had fought his battery the whole day; he was the only man who knew anything about it, and he had done his best. After I retired from the Navy, and joined the Volunteers, I spoke to my Colonel on the machine gun question, because I felt convinced it had a great future; and Colonel Alt agreed with me and other Officers of our corps that it would be a very good thing to have a machine gun or two and see what could be done with them. We consequently obtained two 5-barrelled Nordenfelts and set to work. We had them mounted with a trail and limber, and compiled a drill for the men. We found that the trail and limber mounting would not answer at all. On reversing to come into action, you had to take a sweep round before unlimbering; your limber had to come away. If you were in square, where was it to go to, or how were you to reverse? We found that it created great confusion, and either upset the companies, or the square was badly formed; so that in the end we had to give up the idea of working the guns with the limber, and we designed what we called a magazine carriage. It is very similar to the body of the Beresford carriage, the end part without the limber, only a trail. We manned these guns with our own men, and we have had them at Portsmouth and at Aldershot; and the Director of Naval Ordnance, who came down to see our carriage and drill, told me the whole thing was so simple and good that any body of men could learn the drill and work the gun and carriage in three days. We tried to study the machine gun question from beginning to end, and the first thing we found had to be considered was the feed. In the machine gun the feed is the principal part of the whole affair. If the feed chokes, the gun is of no use; and as Commander Rolfe wrote Lord Charles Beresford, the guns in the Soudan did choke. In a gun with a single feed, with only two barrels, like the Gardner, the cartridge going first into one barrel and then into the other, if the one barrel is choked the whole gun is disabled. We have had several cases of barrels being choked from defective cartridges; the head of the cartridge was torn off when firing very rapidly. One of my men can fire about 600 rounds easily in 1½ minute, and 100 rounds in 6 seconds, and put the greater number of them on the target at 1,000 yards. If the barrel chokes, the feed should be so regulated that the other barrels can be fired without having to suspend firing; then if you have only one or two barrels to a machine gun, you are simply aiming at one man with one shot, whereas if you are firing volleys of, say, five bullets, you have a far better chance of hitting. If you aim at a partridge with a rifle you may miss him, whereas if you aim with a charge of shot you are safe enough to kill him. It is the same thing with the machine gun. Say, for instance, that you have the head of a column

advancing through a road; you can understand the fearful execution that must result from the machine gun firing in volleys. We had a jam the other day at Aldershot through the head of a cartridge being pulled off in the left barrel. We at once cleared the whole of the channel for that barrel, and went on firing as if nothing had happened. You can do that with a gun where every barrel is fed by itself, and that is a point really worth considering, as I pointed out to Sir Archibald Alison at the time. The first thing to consider is the feed of your gun, because everything depends upon that. The second thing is the nature of your firing action, whether you can keep your eye along the line of sight. Now if you use a rotary motion, you continue to raise and lower your body in firing, and this takes your eye away from the sights and spoils your firing. So if you use that motion, you will find it is impossible to keep the object on and fire accurately as you can with the horizontal lever action. It is somewhat remarkable that now, after the machine gun has been used in action in the Soudan, the Officers in command have found out exactly what we found out two and a half years ago, viz., that the limber carriage will not do, that you cannot limber up and unlimber rapidly in action, and that you must have a carriage that you can always use "in action," that is to say, turned so as to keep the muzzles pointing to the enemy.

Admiral SELWYN: I hope that for the future there will be no question whatever as to producing any sort of rifle for the infantry that does not carry a cartridge suitable for the machine gun. I view with the greatest horror any introduction of a very small bore rifle which may not suit the machine gun and a cartridge corresponding to it. If the two things are taken together, and the consensus of opinion on the machine gun is added to the consensus of opinion on the infantry rifle, I think we shall get a cartridge which will supply both, and short of that I am quite sure the adoption of any two natures of cartridge in the field, however little they may differ, will be found to be an immeasurable evil.

The CHAIRMAN: I will not at this late hour attempt to summarize the remarks which have been made, but I may be permitted to offer a small contribution of my own. I must observe that the old difficulty as to the place of machine guns in the field has not been very much solved by the discussion at this meeting. We are still met with this primary limitation, that the machine gun has its sphere of action within musketry range. No one contends that it can combat artillery at artillery ranges; and we are aware that there are no means of learning whether at long ranges generally it is hitting its object, or falling short, or passing over. Therefore I still suppose the sphere of the machine gun is within ordinary musketry range. That is very satisfactory as a statement of one of the elements necessary in the determination of the tactical place of this piece in the field; but it entails the question, how can it be suitably mounted? Now there are two kinds of warfare in the field generally known to us as European and savage warfare. We use machine guns freely in savage warfare, may be with great effect, and not without risk; but in European warfare, as opposed to trained infantry skirmishers, I do not see how you are going to get these things (pointing to the various guns and mountings) about.

Lord CHARLES BERESFORD, in reply, said: Admiral Boys made a remark as to the utility of having guns with very few barrels instead of guns with many barrels. I think Mr. Nordenfelt answered that. The advantage of the machine gun is its power of being able to fire a great number of bullets very rapidly and accurately. You do not want to keep on pumping away, but you want a machine that should have it in its power to be able to pump its lead with great rapidity and accuracy for a certain time. There was a remark made about the mounting. The real object of my venturing to address you at all on this subject is contained in that question of mounting. There are many arguments for and against these guns. One argument that is often used is that you cannot put a machine gun anywhere that could not be better replaced by a rifle, and how in the face of infantry skirmishers are you to get it to a place where it may be useful? Well, I think that there are places where it will be invaluable, and my object is to have it placed on such a mounting that it can go with mounted infantry, or cavalry, or artillery, and reach the required position in the least possible time; when once it gets there it may be able to hold its own. The question of mounting for naval purposes has been commented on, and I think the observations made were certainly gratifying to myself. Captain Armit

has told us what similar guns did without a limber, and Captain Wilson's letter showed how much better they would have worked the guns without the limber in the Soudan. Colonel Holley spoke about reversing. The carriage I have suggested is so designed that the gun should always be in action; that is so that in galloping or halting it is always in action. You may be in a position where you want to reverse very suddenly, and in this case while it is reversing you can go on firing. As far as the different classes of machine guns go, I have no interest in one gun more than another. I think there are many things in the Nordenfelt that are very good; there is also very excellent method in this Gardner gun, and the Gatling gun is a capital gun, because the way in which it can be elevated or depressed is quite perfect. I do not care myself much about the rotary motion, because it rather invites accident. Supposing anything jams, you are out of action altogether, because you have to do five things at once; you have to turn the handle, turn the barrels, extract empty cylinder, and to fire and put in the full cartridge. On the other hand, this gun has certain great advantages over the others, but which is the best I would not pretend to say. The point I wanted to bring forward is the question of the mounting. The guns are allowed to be useful under certain circumstances, and the main point is the best way of mounting them so as to avail yourself of their advantages when those circumstances occur.

The CHAIRMAN: I think the meeting will empower me to return our hearty thanks to Lord Charles Beresford for his interesting and suggestive lecture, and to express the hope that he may give us further information on this subject on a future occasion.

Wednesday, July 23, 1884.

ADMIRAL THE RIGHT HON. SIR JOHN C. DALRYMPLE HAY, BART., C.B., M.P., &c., &c., Vice-President, in the Chair.

A REVOLUTION IN THE SCIENCE OF GUNNERY.

By Lieut.-Col. W. HOPE, V.C., Commanding 1st City of London Artillery Volunteers.

The CHAIRMAN: My lords and gentlemen, I have the honour of introducing to you Colonel Hope, who is about to give us a lecture on a subject which I am sure is most interesting at the present time, and which will be listened to with attention and interest. Many of you probably know Colonel Hope—a very distinguished soldier, who did his duty well in the Crimea, and who wears the highest decoration a military man can wear, for his gallantry displayed in one of the bravest regiments in Her Majesty's service, then the 7th Fusiliers. Although perhaps it is unfortunate that Colonel Hope changed his sword for a diplomatic ploughshare, still, when he was doing service for his country in diplomacy I am sure that the particular subject about which he is going to address us engaged his earnest attention, and I am glad to see here the noble lord then the Minister at Washington and Ambassador in Russia to hear the lecture which will embody all the information which Colonel Hope was able to obtain when he was performing his duty in that other profession under the noble lord now present.

I HAVE called this paper "A Revolution in the Science of Gunnery," because it is a Revolution, and nothing short of a Revolution, that I claim to effect, and that in the opinion of competent men of science and artillerists who have witnessed my trials, I have, as a matter of fact, accomplished.

The Science of Gunnery, or Ballistics, is too often lost sight of, and too often confounded with the science and art of Gunmaking, from which it is of course entirely distinct. The human mind has apparently an irresistible tendency to get into a groove, and once in that groove to remain there, travelling along in it, and working it deeper and deeper, until at last all external objects are shut out from view as in a Devonshire lane. This has been especially the case in this matter of Guns and Gunnery, and, no sooner out of one groove than the Artillerists have straightway tumbled into another.

Now when during, and immediately after, the Crimean War, the first attempts were made at producing rifled Guns, artillerists in all countries, except the United States, had got a rooted idea that guns must be more or less of certain sizes and shapes. They might be a little longer or a little shorter, or a trifle heavier or lighter, but they must not depart very far from certain standards, and they were called a 24-Pr., or a 32 Pr., and so forth. This system of nomenclature was, in the minds of artillerists, fixed by the eternal fitness of

things, as the old phrase has it, and it would to their minds have been impious to call Guns by any other names. Accordingly it is a fact, and a very curious one, that for some time they continued to indicate the size of a rifled Gun not by the weight of the elongated projectile for which the Gun was made, and which, as a matter of fact, they fired out of it, but by the weight of the spherical solid shot which would enter the bore, and, if my memory does not deceive me, this was the practice in all other countries as well as in England.

I mention this curious fact to show that at first the introduction of rifled Guns was a mere workshop, rule of thumb, improvement, and not a true advance in Science. And I show this because I desire to point out that the existing proportions of Guns—I am speaking from the ballistic point of view and therefore of the bores only—are merely slight developments of the old order of things, and, being founded upon superstition and rule of thumb, are not entitled to any reverence or respect. So that when I claim to revolutionize Artillery, I am committing no act of iconoclastic impiety, and I am guilty of no scientific heresy.

Moreover Science is revolutionary in her very nature, and although I am unfortunately compelled to differ, as widely almost as it is possible to differ, from the official text books on Gunpowder and on the Construction of Ordnance, still my views are only the logical and direct sequences of those of some distinguished Artillerists, English as well as foreign; and among these I may mention Colonel Sladen, formerly, when Captain, Professor of Artillery at the Academy at Woolwich, and Colonel Brackenbury, the present Superintendent of the Royal Gunpowder Factory.

Further to secure myself against the imputation of rashness and presumption I will proceed to read four remarkable extracts:—

The first extract is from the official text book on "the Construction of Ordnance," and is as follows:—"We manufacture our present Ordnance from mild steel toughened in oil for the inner barrel, and from good ductile wrought iron for the remaining portions.

"So admirably do these materials answer, as we now employ them, that we may boast of having thousands of rifled guns thus built up, from the 9-Pr. weighing but 6 cwt., to the 16-inch gun of 80 tons weight, not one of which has burst explosively on service, nor has the sacrifice of a single life been due to their breaking up." No sooner was that published than the 38-ton gun burst with terrible effect on board the "Thunderer."

The second extract is from a very remarkable Petition to the House of Commons, presented in 1880 and praying the House to investigate the Petitioners' allegations, and "to provide Her Majesty's Government with independent technical advice, representing the most advanced science of the day." The Petition is signed by (among others, including I am proud to say myself) three very eminent Fellows of the Royal Society, Sir Henry Bessemer, Mr. Merrifield, and Professor Osborne Reynolds. I extract the following:—"That your Petitioners have devoted special attention to questions of Gunnery, and to the construction of ordnance. Certain of them

have also attained some eminence as metallurgists, engineers, and inventors.

"Their theoretical studies and practical knowledge lead them unhesitatingly to the belief that the system of heavy ordnance now in use and known as the Woolwich system is inefficient and dangerous . . . .

"Your Petitioners look with dismay upon the defects of the English heavy guns, and they are of opinion that these defects seriously endanger our naval supremacy and our national safety . . . . false information and wrong principles have been officially disseminated and taught in both Services."

My third extract is taken from the paper on "the heavy guns of 1884"[1] read on the 19th of last month by Colonel Maitland, the Superintendent of the Royal Gun Factory, and is as follows:—"I felt therefore that the time had now arrived for as clear an exposition as I could lay before you—and through you the public—of the present state of this subject, which is of national importance, setting forth the causes which had led to the necessity for the rearmament of our naval and military forces . . . .

"It may be admitted that during the latter part of the seventies England fell behind in the Artillery race . . . . During the last three years we have been endeavouring to make up our leeway . . . .

"The main difficulty has been to obtain sufficiently large steel forgings for these immense weapons. There are in France and Germany several firms which have been able to supply steel forgings of the size, and also of the quality, required for these guns; but up to the present time the demand has been a new one to the English trade, and there has been great difficulty in obtaining from the English trade steel forgings of the size and quality required."

My next and last extract is from the Report of a special "Board" of United States Army and Navy Officers, sent over to Europe last year to examine all the systems of artillery, and matters connected therewith, to be seen in Europe. The Report is dated the 16th February of this year, but the extract refers to what they saw at "Manchester, England, on Tuesday the 9th October, 1883." My extract is:—"Upon its first arrival in London, the Board was invited by Sir Joseph Whitworth to examine his works, but with the desire expressed that the visit should be postponed until the close of our foreign investigations. This request was, of course, readily acceded to, and it will be thus seen that previous to the visit to Manchester the members of the Board had received all the impressions that could be produced by viewing the operations at the chief steel factories in France and Russia, and the great factories of Sheffield in England.

"In speaking of the Whitworth establishment at Manchester as unique, and of the process of manufacture at that place as a revelation, reference is specially made to the operation of *forging*. As

[1] See Journal, No. CXXVI.

to the assorting of ores, and the treatment of metal in the furnaces, there is no intention to draw distinctions; but as to the treatment of the metal after casting, there can be no doubt of the superiority of the system adopted by Sir Joseph Whitworth over that of all other manufacturers in the world."

The Board then go on to describe his process, of worldwide celebrity, for the "fluid compression" of steel, and his less known process of forging by hydraulic power, and mention ingots of 45 tons as being forged in that manner. I ought perhaps to mention that I have no connection, direct or indirect, with Sir Joseph Whitworth. I have not the honour of his acquaintance, and do not even know him by sight.

That is the end of my extracts, and they are so remarkable that I trust they effectually secure me against the charge of rashness and presumption when I talk of "revolutionizing" the science of gunnery, or when I venture to criticize the manufacturing Department at Woolwich. Down to the 19th of last month, however, when Colonel Maitland read his paper, Woolwich would not admit the truth of the criticisms of men of science, and the House of Commons generously supplied it with all the money it asked for, until we are suddenly told by Woolwich itself that the Petitioners of 1880 were quite right; that the information disseminated by Woolwich has been—as the Petitioners said—"false," that is, false scientifically; that the principles taught by Woolwich have been—as the Petitioners said—"wrong;" that consequently our "Woolwich" guns are—as the Superintendent of the Royal Gun Factory says—"obsolete;" and that as long ago as 1875 we were, to the knowledge of Woolwich, "distanced in the artillery race." And now when at last this confession tardily comes, there is coupled with it, as an excuse for Woolwich, a wholly unfounded charge against English steel makers.

What? England behind France and Germany in steel making? England? the country of Sir Henry Bessemer, Dr. Percy, Mushet, Sir William Siemens, Sir Joseph Whitworth, Sir John Brown, Cammell and Co., Vickers and Co., Firth and Co., and many more?

The Superintendent of the Royal Gun Factory ended his paper with these words:—"I will conclude by earnestly representing that though sufficient confidence may not have been felt two or three years ago to justify the heavy outlay which was seen to be necessary to rapid rearmament, yet that now the time has arrived for the country to face the question seriously, to grant the money, and to push the manufacture."

That is a perfectly frank straightforward statement, and I will be equally frank and straightforward. The object of this paper is to prevent the money being granted to Woolwich for the manufacture of the fearful and wonderful engines of war, still fortunately *in nubibus*, but whose portraits by anticipation were exhibited on these walls on the 19th ultimo, and which may be shortly described as "the De Bange-Franco-Marine-Prusso-Elswick-Woolwich Guns of 1884."

Now when a man has unmistakably done his very best, has his

heart in his work, and has spared himself no pains to do his work as thoroughly and conscientiously as is within his power, it is a most ungracious task to criticize that work adversely before the very people whom he desires the most to please and to convince. No one can have listened to Colonel Maitland's paper the other day without feeling that he was just such a man, and his paper just such an effort, as I have described. Moreover, with the exception of the condemnation of English steel makers, and one or two other points, it was a fair exposition of the science of Gunnery (so far as it touched upon Gunnery) and of the science and art of Gunmaking, as they exist and are understood in the different arsenals and factories of Europe at the present day.

But, had I criticized it at all, I must have done it so very damagingly, that I confess that I had not the heart to do it; I preferred to congratulate him on the candour with which he had thrown overboard the Official "Treatise on the Construction of Ordnance," and to respond to his appeal for an explanation of why he could not fire more than a certain quantity of powder, measured by calibres in length of cartridge, without setting up dangerous waves of pressure.

I find, however, that my forbearance has been misconstrued to mean acquiescence in his views as to how Guns should be constructed, whereas I differ with everything that he said on the subject, and I feel it my duty publicly to say so. I also find that the fear of exceeding my allowance of ten minutes caused me to omit a portion of my explanation, thinking that everyone would see it as a necessary consequence of the other part, whereas neither Sir Frederick Bramwell nor Mr. Barlow, the two civilian members of the Ordnance Committee, saw what I left out as a necessary consequence of what I said, and therefore it is obvious that my explanation was too much abridged, and I am anxious to complete it. For these two reasons I asked the permission of the Council to read this paper, and as I said before, its object is to prevent the manufacture of Guns at Woolwich being proceeded with.

But before going forward, let us first go back a little, and, reviewing the past, let us endeavour to trace out how it can be that British Guns and Gunnery have got into the extraordinary and chaotic condition, indicated by the extracts I have read, and which have caused them to be the laughing-stock of Europe. I mean literally the laughing-stock, for I have heard foreign engineers—yes, and English engineers too—make very merry over the wisdom of Woolwich in strengthening a comparatively hard, strong, and elastic steel core, by wrapping round it comparatively soft, weak, and inelastic but plastic, iron.

Let us suppose that shortly after the close of the Crimean War, say in the month of December, 1856, when my Shrapnel or Canister Shell was rejected by the President of the then Ordnance Select Committee, on the ground that "rifled guns would never be introduced into the *British* Service," a Royal Commission on Gunnery had been appointed, composed of the very first Physicists, Mathematicians, and Chemists of the day, such as Faraday, Brewster, Adams, Mary

Somerville, Whewell, Joule, Grove, and Macquorn Rankine, with special instructions to work out the full advantages to be gained, if any, from the contrivance of causing an elongated cylindro-conoidal projectile to rotate round its major axis; it may be safely predicated (1) that before the end of 1857 such a Commission would have reported in favour of the adoption of rifled guns, and (2) that they never would have designed a short fat shot of two to three calibres in length with a flat base, followed through the air by a complete vacuum. I appeal to the Naval Members of the Institution present to say whether a ship would go as well through the water if she were sawn in two at the mizenmast, and sent to sea with a perfectly flat stern. Give her the same engine power and yet with less weight, but minus her clean "run," she could hardly be driven through the water 2 knots an hour, but would act like the sucker of a pump.

As with ships so with projectiles, though in a minor degree, owing to the less density of the fluid in which they move. To attempt to drive a short fat projectile with a flat base at a high velocity, is flying in the face of science by wasting power unnecessarily. Why do the countrymen of Newton not endeavour to adopt a "Form of Least Resistance" for their projectiles as well as their ships?

Had my imaginary Scientific Commission been appointed in 1856, they would, however, in the first place, have been brought up short by the metallurgical difficulty of making a Gun to stand the increased strains, due to firing long and heavy forms of least resistance. But a Commission of such men, with John Bull's purse to aid them, would always overcome any such mere workshop difficulty. Let us for the present suppose, therefore, that they had produced a Gun that was structurally sound and strong. Then they would have been brought up by Colonel Maitland's difficulty, namely, the impossibility of firing a longer cartridge of powder than $3\frac{1}{2}$ calibres, or some such length.

I have said "Colonel Maitland's difficulty," merely because he gave it a prominent place in his paper, and very frankly confessed that to him it was an insolvable problem. Sir Frederick Bramwell said the same, and Mr. Barlow said the same. But this is due to no reprehensible ignorance on their part. It simply represents the existing state of the science of Gunnery all over the world. Mr. Rendel did not acquiesce in Colonel Maitland's limit of $3\frac{1}{2}$ calibres, and was inclined to put the limit at "4 to 5," but that is a mere detail. He entirely agreed that a limit existed, and was very soon reached, beyond which you could not—dare not—go, in the charge of powder, even with the slowest burning, feeblest varieties. A French Colonel of Artillery would tell you the same. An Austrian would tell you the same. Herr Krupp would tell you the same.

But can you believe that the Commission which I have supposed to have been appointed in 1856, or one appointed to-day, composed of, say, Professor Cayley, Sir William Thomson, Professor Tyndall, Professor Williamson, Sir Frederick Abel, Captain Noble, Dr. Percy, Mr. Crookes, Dr. Pole, and Mr. Justice Grove again (if judicial etiquette would permit the learned judge to forsake for a time the Bench for

the Laboratory)—can you believe I say that such Masters of Science would be very many months in solving what would be to them so very simple a problem? Certainly not. I cannot believe it, and for the reason that I myself—a very humble worker in science, when compared with such Masters as Faraday and Tyndall, Brewster and Thomson,—have discovered the cause, and invented the remedy.

I mentioned the other day that I had actually fired, without danger or inconvenience, no less than 15 calibres of powder. But the truth is that I can fire an *unlimited* quantity of powder, in a gun of given calibre, provided of course that the chamber is made long enough to hold it. Theoretically, and I believe in actual demonstration, after careful calculations, and a few experiments, I could fire 150 calibres of powder just as easily and safely as 15. And although it took me eleven years, namely, from the autumn of 1869 until the month of January, 1880, to work out this problem, I altogether refuse to believe that either of my imaginary Commissions, composed of men with such vast stores of knowledge, of such transcendent talents, and with all the resources of the British Government at their disposal, would have been kept back more than a very few months, or more probably weeks, or days, by any such difficulty. Had they been called in, Millions of money would have been saved, and our Guns would not have been obsolete. Why were they not called in? It is our boast that English men of science are the Pioneers of the world. Why do we not make use of them for the public Service when new problems arise? I am the more confident that such men would soon have solved such a problem because I have had the honour of working on scientific Committees with some of them, and I know how difficulties vanish before them.

Now when a thing has been explained, it is often so exceedingly simple in reality, that one has a difficulty in believing that it ever could have been a mystery. Therefore you must not laugh at me for taking eleven years to finally puzzle out and understand one problem, and the results to be obtained through its solution. Moreover when I heard men talking of "waves of pressure," I pictured to myself the powder-chamber of a gun filled with gas rushing forward and being stopped by the projectile, as by a dam, and I broke my head over impossible calculations. This phase of my floundering became more acute after hearing a most interesting lecture by Professor Clerk Maxwell on "Molecules." I then saw mentally the molecules rushing about in my mental powder-chamber and quarrelling with one another, and I formed a dozen wild notions to account for the phenomenon to which Colonel Maitland called attention.

Then some words of Sir William Thomson came to my rescue by bringing me back to sober common-sense, for the words "accurate measurement" rebuked me. "Yes, but how am I to apply them?" That no doubt was a puzzle, but still they made me feel that I was proceeding by a wrong method, and that I must look for a simpler solution, and I eventually found it, as I will presently explain. But I will proceed step by step.

In the year 1869, I commenced by inventing a contrivance for

accomplishing what Sir William Armstrong had tried to do unsuccessfully, namely, relieving his gun by moving the shot as the first effect of firing the friction tube. My idea was to introduce a little cannon axially into the base of a metallic cartridge, to carry forward the barrel to the base of the projectile, and to perforate that portion of its barrel in front of its powder-chamber. I had got no simple form of breech-block, however, that pleased me, and after some time I put away the question of breech-loading to be solved at a future day, and designed a little bronze cannon with a long barrel, and with an intermittent screw on the outside of the breech and powder-chamber, to be inserted through the breech of a muzzle-loading big gun, and to be run up through an air space in the centre of the big cartridge, after being itself loaded with a little cartridge from the muzzle. It was then to be fired through an axial vent. The effect of firing it would evidently be to relieve the big gun by moving the projectile or overcoming its inertia and bringing it to an equilibrium, and the perforations in the barrel of the little gun would secure a very perfect conversion of the powder into gas, before the projectile left the gun, by igniting it in so many places at once.

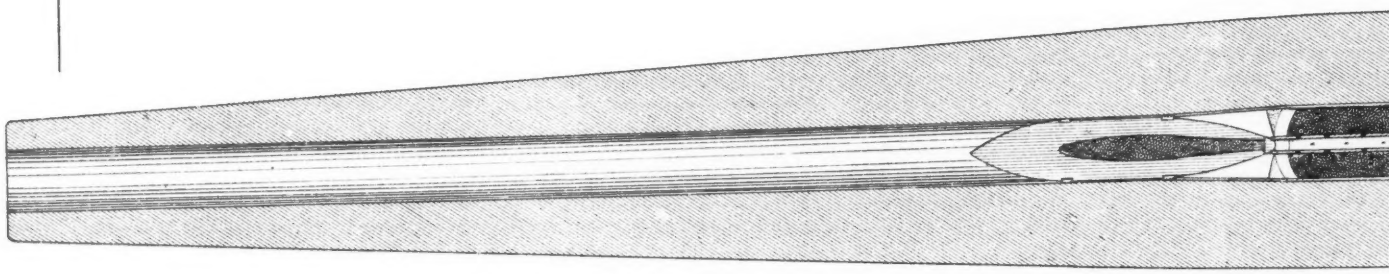
There is no doubt that such a contrivance would act satisfactorily, but I bottled it up for two reasons, first because muzzle-loading guns were, in my judgment, essentially wrong, and I would not do anything to perpetuate them, and, secondly, because I was brought up short by the two questions, "How is the proper charge of powder in a gun determined?" and "Why will every gun burst if the length of the charge of powder be increased beyond a certain point?"

When I put the first question to one friend he said, "Oh, some scientific man has settled all that." When I asked an old friend of mine in the Navy he said he thought it had been "settled in the last century by some mathematicians." When I asked a friend of mine who was a great mathematician, he said he thought it was "by rule of thumb."

The second question I have put to a great many naval and artillery Officers of many different nationalities, and I have invariably got the same answer, "Oh, because if you put in too much powder of course you burst the gun." "Yes, but why?" "Well, because you put in more than the gun is intended for." "Yes, but what does that mean?" "Why that the gun will stand a certain quantity of powder and no more." I have been given all sorts of illustrations, but they have always turned out not to be analogies, and I have never got from any one, in any country, any explanation whatever. The gun bursts, because it bursts. The Superintendent of the Royal Gun Factory has told you that it is an insolvable problem, and Sir Frederick Bramwell, and Mr. Barlow, the two Civil Engineers on the Ordnance Committee, have told you the same, and at this moment it is so regarded by artillerists all over the world.

And there I stuck, I am not ashamed to say, for years. But Sir William Thomson came to my rescue again and encouraged me with his phrase "patient long-continued labour," and I kept on puzzling over it. There *must* be *some* solution.

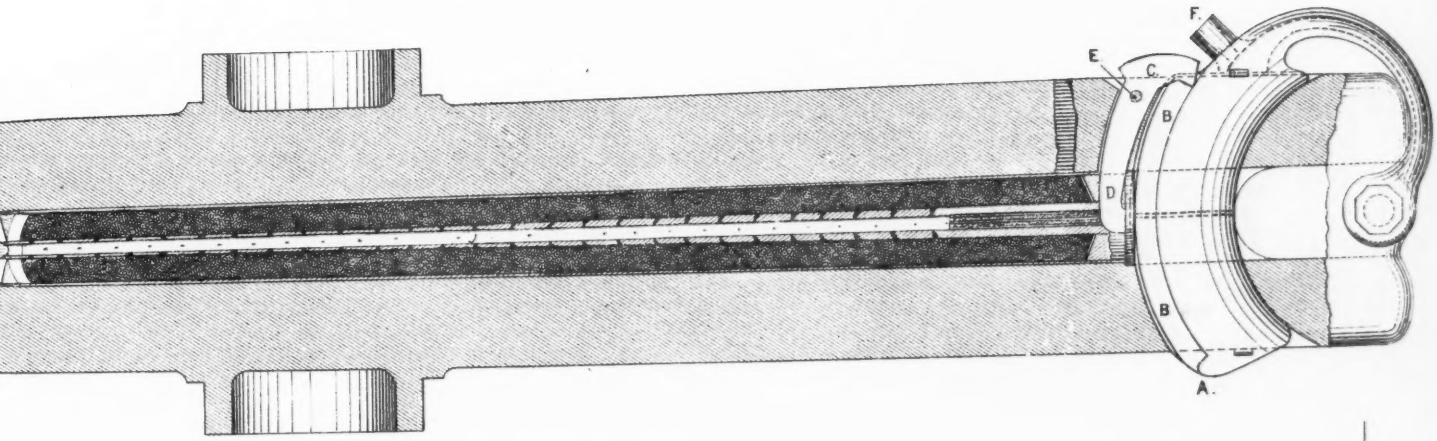
A TYPICAL "H



In scale of

Harrison & Sons Lith.

CAL "HOPE" GUN.



scale of Calibres.

...son & Sons Lith. St. Martins Lane W.C.

I then went back again to the question of a breech-block. I wanted a very strong solid block to oppose a brute force resistance, so to say, to the ejection of the metallic cartridge, on which I counted for obturation. This idea I have had very firmly rooted in my mind ever since reporting on the "Morse," now "Springfield," breech-loading small arm, in December, 1857, when I was attached to Her Majesty's Legation at Washington. That rifle had a metallic cartridge, the first I had ever seen or heard of, and I was satisfied that in that lay the true secret for securing a satisfactory obturation, and of course if that were true for small arms, *à fortiori* it must be much more true for large guns.

But a large wedge driven through the side walls of a gun must necessarily be a heavy cumbrous thing, and I wanted some contrivance for taking the weight off the gunner's hands, as in a big gun, which is a most serious consideration.

At last, in the beginning of 1879, I hit upon the idea of curving the wedge, as you see in the drawing upon the wall, and hanging that by a double ⊤ piece on the roof of the bore to the rear, and pivoting it. This I believe will turn out a useful invention of the class which I term "workshop inventions," and will be a decided improvement on any form of straight wedge, while the French and English breech-blocks are the weakest of all, being merely corks stuck in bottles, the intermittent screws of which are bound either to strip, or to set up and jam, with a really large charge of powder. Another convenience about my breech-block is that when it is smartly opened, by a handspike inserted in the socket F, the shoulder A, at the end of the slot B, strikes a blow upon the short arm C of the lever CD, which is pivoted at E, and this arrangement being in duplicate, one lever above the cartridge, and one below, the two long arms simultaneously catch hold of the rim of the empty cartridge case and eject it.

I was so pleased with this block that I determined at last to get out a working drawing of a gun with my little gun inside it. Then I was once more brought face to face with the old insolvable problem, for I wanted of course to get a very high velocity, and to increase the charge of powder beyond the usual proportions, how was I to do this without bursting the gun?

I did my best to obey Sir William Thomson and "accurately measure," but how was I to measure? I went to the official "Notes on Gunpowder," and found "when a charge of gunpowder is exploded in the chamber of a gun, a large quantity of gaseous matter is evolved in a highly condensed state, its tension or expansive power being, moreover, greatly increased by the heat generated by the explosion. The pressure is, of course, equal in all directions."

Here was another puzzle! The pressure equal in all directions? How about "waves of pressure"? Since then the official "Notes on Gunpowder" have been revised, and very greatly improved, but this same passage is preserved, textually, in the present edition, out of which the British Artillery or Naval Officer is taught.

But if a long charge of powder will burst a gun, which a shorter

one of the *same powder* will not burst, how *can* the pressure in the powder-chamber be equal in all directions? But if the pressure in a powder-chamber is not equal in all directions, and increases with the length of the cartridge, *why* is it not equal, and *why* does it increase with the length of the cartridge?

Probably a properly selected Committee of the Royal Society, well up in Thermo-dynamics, Kinetics, and Vortex-motion, would have solved this problem, if not at their first meeting, at all events at their second, by a process of elimination; but the more I puzzled over it, the less I seemed to understand it.

Then I turned to the official "Treatise on the Construction of Ordnance," to see if I could get a wrinkle from what was said there about bursting strain. There I found the old formula for the bursting strain set up in a hollow cylinder, by an uniform fluid pressure, namely $P \times R$, where P is pressure in unity, and R is the radius of the bore in the same scale. That is the formula for calculating the circumferential or transverse strain tending to split the gun longitudinally, and the longitudinal strain, tending to break the gun across, is dismissed in a few words as not being worth talking about.

But the formula $P \times R$ being based on the same assumed uniformity of pressure, spoken of in the text-book on gunpowder, must be untrue also, when applied to the powder-chamber of a gun, and the Superintendent of the Royal Gun Factory has told us that it *is* untrue. It *must* be untrue; for the *length* of the charge is not a factor in the equation, and yet Colonel Maitland has told us—and correctly, that it is precisely the *length* of the charge, measured by calibres, which governs the pressure.

Here then are two more specimens of the "information disseminated" by Woolwich, one in the text-book on Gunpowder, and the other in the text-book on Construction of Ordnance. The pressure of gas as a fluid is of course, in the abstract, equal in all directions, that is to say practically speaking. But the statement in the text-book on gunpowder is that it is "equal in all directions" "*in the chamber of a gun*," and this is the assumption in the formula $P \times R$.

I then put to myself the question, "Is the formula $P \times R$ true, given uniformity of pressure?" and I found that it was. Here then was daylight at last, for this was positive proof that the pressure is *not* uniform in the chamber of a gun.

Now I had something to work with. If the pressure is really not uniform in the chamber of a gun, at all events with a long charge of powder, *why* is it not uniform? There must be some *cause* for an apparent departure from a well known law of nature. What is the cause? Here Sir William Thomson's "accurate measurement" helped me again, for I saw that I must try and ascertain what goes on in the powder-chamber of a gun, when the Officer gives the word "Fire," and the Gunner pulls the lanyard.

Well, what does go on? Take the case of an ordinary old-fashioned gun with the vent at the top and at the rear of the chamber. The passage which I have quoted from the text-book on gunpowder says "when a charge of gunpowder is *exploded* in the chamber of a gun,"

but probably there is no one present here to-day who would venture to stand up and say that gunpowder is an explosive in the sense used here, and in the sense in which nitroglycerine is an explosive, that is an unstable chemical compound which ignites simultaneously throughout. We know that gunpowder is a mechanical mixture instead of a chemical compound, is *not* an explosive, and does *not* explode, more particularly the large-grained powders of high density of the present day. Yet the text-book talks of it as "exploding," and the formula for bursting strain is based on that assumption, and we still set fire to it in exactly the same way as at the battle of Crécy in the year 1346, namely, through one single vent.

But if it does not "explode," what does that mean? What does it do? It means that the element of Time is introduced in its conversion into gas, and that is a completely new factor. It means that in the case of a cartridge set on fire through one single vent, and that vent at the rear, a measurable space of time must elapse between the ignition of the rear part, and of the front part. During that space of time what is happening?

We clearly have a differentiated condition of things in the chamber. The top of the rear part, immediately underneath the flame from the vent, is instantaneously converted, in a closed chamber, into gas of a normal pressure of no less than 42 tons to the inch. That is a tremendous pressure, and there is no escape for the gas except by driving out the projectile with which it is not in contact, for there is all the unignited powder, and the air in the interstices, in between. It cannot escape laterally or to the rear, on account of the rigid walls of the gun, while in front of it, it has the projectile eventually blocking the way, and until it moves, converting the chamber into a closed vessel. Between the gas and the projectile, however, is all the unignited powder. Now until this ignites it is merely an inert mass like sand or hazel nuts. Moreover it is an inert mass which is very compressible, compared with the rigid walls of the gun. It is therefore driven forward, or pushed along, in front of the gas, all the while catching fire itself, and is compressed against the base of the shot, until the accumulated pressure moves the latter.

In the case of a long charge, with a heavy projectile in front of it, the compression is very great, and the powder is jammed violently against the inner surface of the chamber, thereby blocking the free passage of the flame over the top of the cartridge, by which, otherwise, an imperfect, rough and ready, happy-go-lucky, ignition of the front part would take place. Of course the extent to which, and the moment at which, this blocking of the passage of the flame takes place, depend on an infinite variety of small accidental circumstances, and would hardly ever be quite the same in any two cartridges, hence the puzzling variations, in degree of pressure, noticed by Colonel Maitland.

But what does this compression of the front portion of a long charge, lighted at the rear, mean? According to Sir Frederick Abel and Captain Noble, gunpowder, when ignited, gives out 280 volumes

of permanent gas at atmospheric pressure, measured at the temperature of the freezing point. But if, before it is ignited, it is compressed into half its original volume, and shut up in a closed vessel of that reduced size, as it will still contain precisely the same ingredients, it will give out exactly the same quantity of permanent gas, and, giving it out in half the space, it will produce exactly double the pressure, and so on. Therefore, one might get a circumferential wave of pressure immediately in rear of the projectile, due to the eventual spread of the ignition to this compressed powder, of theoretically unlimited energy, and, practically, of sufficient energy to burst any gun, because no gun is constructed to resist it.

In one of the best treatises on the "Principles of Gunnery" that I am acquainted with, by Captain (now Colonel) Sladen, at that time (1879) Professor of Artillery at the Academy at Woolwich, and printed at the Royal Artillery Institution, he says: "It has been found that there is a danger in firing very long cartridges (even when air space is given) of setting up *wave action*, which increases the local pressure in the powder-chamber abnormally."

An objection raised is that the modern large-grained powders are made under very high pressure, are highly condensed, and burn slowly in consequence. That is quite true, but they are condensed in the condition of *paste*, and all air is squeezed out of the paste; whereas the compression of the powder in the chamber of a gun is the compression of *grained* powder, and the air spaces or interstices between the grains are compressed along with the grains, and the grains are moreover crushed and broken, so that ignition would travel actually *faster* through powder in such a condition than through the same powder in its original condition, for the inflammability would be increased by the crushing of the grains, and the distance for the flame to travel would be reduced.

A very good illustration and complete proof of this is to be found in the case of the powder charge of a shell. When the gun is fired the gas from the powder pushes forward the *shell*, but, not being in contact with the *powder* in the shell, it does not at first move it. Its inertia keeps it stationary, and it is violently set up against the rear of the chamber in the shell by the forward movement of the latter. And as a matter of fact the bursting charge of powder in a shell which originally filled its chamber is compressed by that initial action into a third, a fourth, or even a fifth of its original volume.

Yet when ignited it bursts the shell by what is to our senses an instantaneous explosion, and I have often thought there was even something specially sharp and vicious about the way in which the powder in a shell in that condition burns. At all events, when it has burst near me I have never found occasion to complain of the imperfect ignition or combustion of the powder.

The objection which Sir Frederick Bramwell made the other day to my, no doubt incomplete, explanation of the phenomenon under discussion, was, as I understood him, twofold: first, that the absolute length of the two cartridges in Colonel Maitland's Diagram No. 22 being the same, my explanation did not apply; and second, that the

absolute length of the shot of larger diameter was greater than the absolute length of the shot of smaller diameter, and therefore opposed a greater weight per square inch of area to the escape of the powder gas, and consequently the pressure in the large chamber ought to have been the greater.

To the first objection I reply that this, like everything else in gunnery, is not a question of absolute, but of proportionate, measurement, not a question of inches but of calibres, or in other words *volume*, as Colonel Maitland has correctly observed and described; and it will be remembered that in Colonel Maitland's Diagram No. 22 the long thin cartridge filled up the long narrow powder-chamber, from top to bottom, much more, both proportionately and absolutely, than did the short fat cartridge, the short chamber; and in addition to that, it extended in length beyond the chamber into the bore of the gun, fitting almost tight in that part, whereas the short fat cartridge lay down in the bottom of its chamber, having nearly half-an-inch (speaking from recollection) of clear space over the top, and a corresponding though diminishing space round the sides. The flash from the friction tube, and the flame from the top grains of powder immediately underneath the vent, would therefore be able to rush along underneath the roof of the chamber, and to lap round the sides of the cartridge lighting it—practically speaking—everywhere all at once, and rendering the text-book on Gunpowder, and the text-book on Construction of Ordnance, both approximately true, by approximately restoring the uniformity of pressure. Whereas in the case of the long thin cartridge in Diagram 22 there is no such space, and the *proportionate* depth to which the first ignition from the flash of the friction tube would sink would be very much greater, because the *absolute* depth would be the same. Consequently there would be a much greater *proportionate* upheaval and pushing forward of the powder. Hence the passage for the flame underneath the roof would be completely blocked by unignited powder in its inert condition, and a large *proportion* of the grains of powder in the cartridge would be compressed against the base of the shot, against each other, and against the walls of the chamber. It is obvious, however, that in this action there is room for any amount of disturbing causes and minute differences, which, taken together, would produce widely differing results, of the most apparently "capricious" character, as Colonel Maitland has observed, for he told us that the pressures in his trials varied from 26 to 40 tons in the 3-inch gun.

Turning to Colonel Maitland's remarks upon this, he says: "The cause appears to be that as soon as the charge is lighted the gas first evolved travels through the chamber from end to end with great rapidity, and sets up a dynamic action of a vibratory or wave character." This is the old and commonly received idea that got into my head, and led me such a dance, especially after Professor Clerk Maxwell's lecture on Molecules, when I had vortex motion on the brain, for these words describe a chamber where no differential condition of things exists, but which is wholly filled with gas rushing "through the chamber from end to end," or else they describe gas

rushing through a space already occupied by powder. I have shown that the very first *flash* of flame in the larger powder-chamber does travel along under the roof and in the space at the sides, and by thus igniting the powder everywhere—speaking practically—at once, partially restores the condition of uniformity of pressure assumed by the mathematicians in their formula P × R. But *except* in that clear space the chamber is filled and blocked with the unignited and inert powder, which, until it is inflamed, might just as well be so much sand or gravel; and the quantity of gas from the friction tube, and the few grains ignited at the instant of the descent of the flash into the chamber, are wholly insufficient to produce any formidable pressure. Moreover, we must remember that the wave of pressure occurs in the narrow choked powder-chamber along which the gas does *not* travel, and not in the wide one with a free passage for the gas. Finally, we must obey Sir William Thomson and measure accurately. Now, when we say that the gas rushes along under the roof and along the sides through the free open space provided for it, what do we mean? Or rather what is the only possible effect of that rush upon the gas itself so rushing?

For some reason or other, presumably on account of the fondness of the human mind for mystery, every one has got "waves," and "vibrations," and "molecules," and "vortex motion," as firmly into their heads on this subject as the Professor, in Kingsley's "Water Babies," got "Bumpsterhausen's Blue Follicles" into his head, and, if I remember right, next to "good advice and the *Saturday Review*," both of which have generally a sobering influence, what did him most good was playing with children and returning to simple things.

So let us come down from dynamic waves to a 2-foot rule, and we find that the space outside the short fat cartridge, in Colonel Maitland's Diagram 22, allows an immense expansion of the flash from the friction tube and the few grains of powder immediately underneath it. Consequently the gas is immensely attenuated, and the pressure of that minute portion of gas which alone does, as a matter of fact, travel "from end to end" of the chamber is immensely reduced. Of course the flow of this minute portion of the gas being stopped abruptly, by what I termed, elsewhere, the dam interposed by the projectile, a dynamic wave action *is* set up, but it is only slight, for by that time the gas has become attenuated and feeble; still it is an immense pressure, as compared with ordinary engineering pressures, and reaching the shot at the *commencement of the ignition* of the charge, no doubt moves it, and so increases the size of the chamber in which the gas is being generated, and as the shot once moved will keep on moving—for the ignition will be proceeding—the size of the gas-chamber will continue to increase and to keep down the pressure.

To Sir Frederick Bramwell's second objection I answer that he is quite right, and that if the extra 2 inches, or thereabouts, of extra length were cut off the thicker shot, and the weight diminished in consequence half a pound, or thereabouts, per square inch of sectional area, the pressure in the larger chamber would be still further reduced, but infinitesimally. In the same way, if the length of the

thin shot were reduced, the pressure in the small powder-chamber would be reduced; but even if the length of the thin shot were reduced by as much as one-half, the pressure in the chamber behind it would not, on the average, be reduced by anything at all resembling the same proportion, because of the choking of the thin cartridge.

In Colonel Sladen's treatise, before referred to, it is stated: "In experiments with a 12-inch gun of 38 tons the Committee on Explosives found that the effect of increasing the weight of the shot from 700 lbs. to 800 lbs., while firing the same charge of P powder, did not appear sensibly to increase the maximum pressure in the bore." So that Sir Frederick Bramwell's second objection, though correct theoretically, has no practical bearing.

Now, in the paper which Colonel Maitland read at the Society of Arts, in February, 1882, he said that in his judgment the chambering of guns had been entirely misunderstood, and that although he intended to chamber his guns, it was only for the purpose of cramming them as full of powder as possible. Quite right on my system, quite wrong on his, and I made a mental prophecy at the time that he would come to grief, and would have to reduce the *length* of his cartridges, more particularly as he used an axial vent, or in popular language "central fire." Just conceive the violence with which the front part of a cartridge, completely filling up the powder-chamber from top to bottom, must be driven forwards and crushed and compressed against the sides of the gun and the base of the shot before the accumulated pressure moves the latter, when ignition is communicated axially in rear.

Referring to the position of the vent, which affects of course nothing but ignition, Colonel Sladen says: "It was found with cubical pebble powder that there was no difference in muzzle velocity whether the cartridge was lighted in the rear or in the service position four-tenths of the length of the battering charge from the bottom of the bore, but that there was a considerable increase in the chamber pressure *near the base of the projectile* when lighted at the rear." Of course, because here you get the maximum pushing forward and compression of the front of the charge. Observe the words "near the base of the projectile." Unless some of the other portion of the charge had been moved forward and compressed into the front part of the charge so as to increase the quantity of powder by weight being burned in each cubic inch of space, what possible cause could there be for this "considerable increase in the chamber pressure near the base of the projectile"?

Now to give a very short description of the gun on the wall. The moment that you can prevent waves of pressure, no matter what the length of cartridge, there ceases to be any reason why you should follow the old ideas of what a gun should look like. You may start, therefore, by giving to your projectile a form of least resistance which will double its weight. Then you may increase the calibre of the powder-chamber to get in more powder, and then prolong the gun almost indefinitely to the rear with the same object.

The board being in this way wiped clean, let us consider what we should put upon it. We want to make a ballistic weapon which shall punch a hole through a huge armour-plate a mile off. The larger the hole the greater the force required, because the punch will not go through unless and until we accumulate into it a certain minimum energy *per inch of circumference*. That is the only way of measuring the penetrating power of a punch, because that is the measure of resistance of the plate.

Therefore, in order to diminish the work to be done, in punching a hole through a given thickness of armour, we should keep the diameter of the punch as small as possible. Next, we must make it long and heavy, in order that its weight and momentum per square inch of sectional area may be so great that the resistance of the atmosphere may be proportionately small, and that therefore the velocity may be well maintained so that the "remaining" velocity at a given point may be high. Finally we must drive our form of least resistance at a very high velocity, because whereas penetration, for shot of equal velocities and diameters, increases in the direct ratio of the weights, it increases for shot of equal weights and diameters as the *squares* of the velocities, so that velocity is the one thing specially desirable.

Now the drawing on the wall (Plate XXXI) is a full size drawing of a 5-inch Hope gun, and the way I came to hit on that particular size and proportion is as follows:—I took the 38-ton M.L. Woolwich gun, as our first serious armour-piercing gun (I am speaking of 1880), and I set myself the problem how to design a gun of the smallest possible weight, and of not greater length (so as to work in the same spaces on board ship), which should beat the 38-ton gun in energy per inch of circumference of projectile.

The first thing was to get a formula which should give me the velocity of a shot of any weight fired out of a gun of any calibre and length, and propelled by a charge of powder of any size. Here was another puzzle, but eventually my formula was complete.

It is not perfect, because the only data I had to work from, or to check it by, were the velocities of the obsolete Woolwich guns, but it works out absolutely correct for every rifled gun in our Service from a 3-inch up to the 100-ton gun. The error—for there is an error—is entirely against the Hope gun, and so I disregard it.

Then having got my formula, I proceeded to make calculation after calculation to ascertain to what extent I could whittle down the 38-ton gun. I made upwards of a hundred such calculations, and found that a 5-inch "Hope" gun, 17 feet 10 inches long, and $6\frac{1}{4}$ tons in weight, would beat the 38-ton "Woolwich" gun, but since then I have gradually enlarged the pattern, with a view to getting still greater results, and in consequence of the success of my experiments. The final outcome is what you see on the wall.

The gun is a 5-inch gun, 46 calibres in length, or the exact length of the 38-ton gun, namely, 19 feet 2 inches, and about 7 tons 5 cwt. in weight; but whereas the length of the bore of the 38-ton gun is not quite 16 calibres, the length of the useful part of the bore of

this gun is about $40\frac{1}{2}$ calibres in length. My shell is 5 calibres in length, and is, as you see, an approximation to a Newtonian form of least resistance, as against the Woolwich shell with a flat base, of $2\frac{1}{3}$ calibres in length. The base of my shell is $21\frac{3}{4}$ calibres from the muzzle; the base of the Woolwich shell is only $12\frac{1}{3}$ calibres from the muzzle. The front end of my powder-chamber is 20 per cent. larger in diameter than the bore of the gun, and it is coned by increasing the diameter to the rear up to an excess of 40 per cent. over that of the bore of the gun. The object of this coning is to facilitate the extraction of the empty cartridge case, which, the moment it is started, is quite loose. Then there is a farther more rapid, but still very gentle, cone, in the length of the tail of the shot, to reduce the chamber down to the bore of the gun proper, and the part occupied by the powder is 19 calibres in length. But these figures can of course be varied.

There is a compressed felt or asbestos wad at the front end of the powder, and a papier-maché mould divided longitudinally into four,—so as to drop off as soon as the projectile is out of the muzzle,—steadies the tail and blocks the air space, while between these two is a lubricant.

The cartridge case is metallic, and probably steel, lined with varnished paper, and covered with varnished cloth will be found the best material. The base of the cartridge case is also of steel, and so also is the little cannon running up the centre.[1]

I have spoken so far only of the inside of the gun, because that is the gun from the gunnery point of view. Now let us see what conditions we get. First of all, although the base of the shot is situated no less than $21\frac{3}{4}$ calibres from the muzzle instead of only $12\frac{1}{3}$, the proportion of the whole volume of the inside of the gun to the volume of the unignited powder is as 42 to 24·72, whereas the total volume of the bore of the 38-ton gun is four-and-a-half times the volume of the powder, taking Colonel Maitland's $3\frac{1}{2}$ calibres as the length of the cartridge, though one of the oddest idiosyncracies of the large Woolwich guns is that you never know, from one month to another, what the regulation charge of powder is. The latest change I am aware of has been to raise the charge of the 38-ton gun from 160 lbs. of P^2 powder to 210 lbs. of a still more slowly burning powder; but the velocity is only very nominally increased, and I neither know the length of this new charge, nor whether it has been finally adopted.

Now the results to be obtained from a ballistic tube of given calibre must evidently depend upon the proportion between the volumes of the entire tube and of the powder, and upon whether or not the powder is really converted into gas within the tube. Woolwich prolongs its guns in front of the shot, in order to convert more of its slow-burning powder into gas. I prolong my gun chiefly

[1] Since writing the above I have been told that metal cartridges are becoming urgently necessary to prevent scoring. It appears that the abrupt shoulders of the powder-chambers in the new 6-inch breech-loading guns get positively blown away in only forty rounds!

to the rear of the shot, in order to get in more powder, and I use quick-burning powder, about whose conversion into gas there can be no doubt. Colonel Maitland said he hoped to get a pressure of about 4 tons per inch as the shot leaves the muzzle of the 63-ton gun. My pressure is 24·72 tons per inch as the shot leaves the muzzle, after travelling 21¾ calibres through the bore.

Colonel Sladen, in the treatise to which I have before alluded, says: "The amount of work capable of being done on a projectile by the charge of powder in a gun depends principally upon the ratio of the cubic space occupied by the charge to the cubic capacity of the bore of the gun."

The question of proportionate volume is well put in the above paragraph, and it is modified by the quickness or slowness of the powder—in other words, its goodness or badness. On this point, what does Colonel Brackenbury, the present Superintendent of the Royal Gunpowder Factory, say in his recent paper on "Gunpowder considered as the Spirit of Artillery"?[1] He says: "When gun-makers (Woolwich?) say, as they frequently do, that their gun will produce a certain effect, provided that a suitable powder be found for it, they mean 'provided that the strength of the gunpowder be restrained, cribbed, cabined, and confined, to suit the weakness of the gun.'"

Colonel Maitland says: "We sometimes hear statements to the effect that the road to improvement lies in the direction of using very quick powders, and making enormously strong guns to withstand the highest pressures powder can give in a closed vessel, namely, about 42 tons per square inch. This system, from an engineering point of view, is no doubt right, as causing the least consumption of fuel; but it is utterly and entirely wrong from an artillerist's standpoint." This is the statement that Mr. Longridge so severely criticized, and I was, I confess, sorry to hear Colonel Maitland give utterance to it. It is one of those statements which sometimes slip from a man's pen against his better judgment.

Now what does Colonel Brackenbury say in another place? "If the powder-makers (Colonel Brackenbury?) fulfilled the old desire to make the strongest possible powder, and if one suppose the interior of the gun, where the powder lies, divided into a number of rings, each an inch wide, we should have, for a 12-inch powder-chamber, a pressure of no less than 1,696·4 tons on each ring seeking to tear it open—in fact, to burst the gun. Now this is just what we powder-makers would like, because tremendous pressure would, other things being equal, mean immense velocities for the shot and more honour to the craft."

This is common-sense, and sweeps away the cobwebs, and Colonel Brackenbury will be happy to hear that I have just made an improvement in gunpowder which does not diminish its safety, but increases its expansion and power, by securing more complete combustion, and by so doing both diminishes the volume of the smoke and clarifies it. I am now ready to use the strongest powder that Colonel Brackenbury can turn out.

[1] See Journal, No. CXXIV, page 379 *et seq.*—ED.

But I must get back to my gun, and to my little gun inside the cartridge. This is of steel. The barrel tapers in thickness as the pressure of the gas generated by firing the little cartridge falls. It comes right up to the base of the projectile, and contains in its chamber enough powder to drive the projectile, one calibre in length, and to cut the Vavasseur copper ring into the rifling. In other words the inertia and the worst of the friction are overcome. Then the barrel is perforated with holes, carefully graduated in size in inverse ratio to the falling pressure due to the expansion of the powder in the little cartridge. These holes again are covered with thicknesses of paper, cloth, or other suitable material, increasing in the opposite or direct ratio of the pressures—that is to say, increasing to the rear. The object of this is again to make the element of time work for me, by opposing a certain resistance to the free egress of the flame through the small holes in rear, and so to give time to the flame to force its way out through the larger and more slightly covered holes in front, and also out of all the intervening holes, at mathematically the same moment; by which means I achieve uniformity of ignition, and therefore I restore the uniformity of pressure in the chamber assumed by the mathematicians; and the ignition, only having to travel radially, instead of longitudinally, is rapid enough even to please Colonel Brackenbury.

But by this time the shot is already moving, the door of the chamber is no longer bolted and barred by inertia and friction, the gas is no longer shut in at the front end, and finding that they can so easily make their escape in that direction, the molecules no longer quarrel with each other, and struggle with the gun, but settle down quietly to their work, and expel the yielding shot so rapidly that it is out of the muzzle before the gun knows much about it.

You see here again I do the exact opposite to Woolwich. Colonel Maitland tells us that his coals burn so slowly that his piston—for a shot is only a piston working in a hollow cylinder—has to be "held fast" until he gets up enough steam. He first stops Colonel Brackenbury, and tells him that his spirit of artillery "must be tamed and kept within bounds," so as not to hurt the delicate guns, and then he sticks a great plug into one of the poor dear things and holds it "fast" for the express purpose of giving Colonel Brackenbury's spirit time to throw off some of its artificial tameness; "which is absurd," as the late Mr. Euclid used to say. My system is at all events logical.

There is another effect which I get, and which must not be lost sight of, and that is the "percussive" effect of a charge of quick-burning powder, ignited in a great many places at once, and so converted into gas with extreme violence and rapidity. Unfortunately there exist no experiments undertaken to ascertain what I may term the static equivalent of percussive force, but let us take one familiar instance. Set a common tin tack on what Brother Jonathan calls its "business end." It takes the utmost force of a very strong man with a very strong thumb, covered by a very thick skin, to send it completely home into the softest wood by static pressure, whereas a

child, with the lightest possible hammer, will send it home with two very light taps at most.

So much for my "Revolution in the Science of Gunnery." I hope I have justified the title of my paper, and I hope that if I have shocked some old received notions, I have shown sufficient cause for doing so.

I will now say a very few words on gun-making. I require for my system a gun of immense strength, and I look for this strength in the direction of extreme purity of materials, perfection of metallurgical processes and appliances, and true molecular cohesion right through the gun from end to end, and from side to side. This conviction, that in metallurgical improvement was to be sought the only sound advance in the strength of guns, was impressed very fully upon my mind by a report made, by one of his Generals of Artillery, to Napoleon I, upon the qualities of Dutch bronze, as made by the family Maritz, at the Government Foundry, at The Hague, and as reported upon by myself when attached to H.M.'s Legation there in the year 1860, and then still manufactured by the last of the family Maritz, by means of a family secret discovered by his ancestor at Berne in the year 1714.

But as this is not a paper on gun-making, and is already so long, I must now be very brief, and can only give an outline of my principles.

The official text-book on "Construction of Ordnance" says: "It is generally agreed that no possible thickness can enable a cylinder to bear a continual pressure from within, greater on each square inch than the tenacity of a square inch bar of the material." I must say that I deny this. The text-book then gives two pages of mathematics, which I have no intention of taking you through, because it sums these up:—"What we require, then, in manufacturing a gun cylinder is not to make a homogeneous hollow cylinder, but so to arrange that the inner portions shall be stronger than the outer parts."

Now, as an old Cambridge man, I cannot be suspected of having any undue contempt for mathematics, but just because I have seen a good deal of mathematics and mathematicians, I never resort to them save in the last and direst extremity. The mathematical work may be all most perfectly right from the 2 and 2 make 4 school-boy point of view, and yet, owing to some erroneous assumption, may be utterly wrong in practice. But it is unnecessary to search for the error in the assumption, if the error in the result stares you in the face. Now these mathematics "run mad" teach that "the inner portions shall be stronger than the outer parts." Follow this up. For the weak outer parts—say the wrought iron of an old Woolwich gun—substitute strong steel, as in a new Woolwich gun, or still stronger steel wire, and, according to the text-book, the cylinder would be weaker instead of stronger; "which is absurd." Here, once more, Cambridge teaching differs from that of Woolwich.

Then Woolwich says the greatest strain, when a gun—considered as a thick hollow cylinder—bursts, is on the inside. I say it is on the outside. Go down to the Arsenal and you will see the "Thunderer" gun, burst on purpose in the Arsenal, split from end to end of the thick

outside coil, and yet the inner tube is not split at all. Woolwich endeavours to transmit the strain from the inside to the outside. I try to absorb it in its passage. I try to fire a charge of powder of maximum size out of a gun of minimum thickness, without bursting it. Woolwich has succeeded in bursting a gun of maximum thickness with a minimum charge of powder.

Woolwich says (*vide* text-book) that the "circumferential stress is so much greater than the longitudinal stress that we need not discuss the latter." I say that the longitudinal strain is the greater, and so say the guns. Both the "Thunderer" guns burst transversely as if cut off with a knife, so did the Armstrong gun on board the "Angamos," while the 100-ton Armstrong on board the "Duilio" pulled out like a telescope. It is the tube of the new 43-ton Elswick gun now in the Arsenal which has burst, and it has done so transversely under the longitudinal pull. And every built-up gun in Europe that has burst, has burst in a similar way, except when there has been a local cause. It was under the longitudinal strain that the breeches of the Krupp guns of the Germans gave way in 1870.

Woolwich talks very plausibly about "taking the longitudinal strain" with this, that, and the other piece, and the latest attempt to neutralize the evils of cutting a gun up into little bits is to run phosphor-bronze into the cracks and crevices, and so to imitate a gun made in one piece. I prefer making a gun in one piece to start with, and having no cracks, for it must be remembered that the external, superimposed "coils," or "bands," or "hoops," or "cylinders," add nothing whatever to the real longitudinal strength of the gun, because there is no *transverse molecular cohesion*. They are stuck on each other exactly as you stick your hat on your head, and in *no other way*. Now the only reason that your hat blows off and that your ears do not, is solely a question of transverse molecular cohesion. That exists between your ears and your head: therefore, and for no other reason, your ears do not blow off. That does not exist between your hat and your head, and therefore the hat is liable to give way under longitudinal strain and to blow off.

As is well said in an article on "Rifled Ordnance in England and France," in the *Edinburgh Review* for April, 1864 (and which is still, after twenty years, most instructive reading): "It is essential to preserve the confidence of soldiers in their arms, and, say what you will, a gun consisting of one piece of solid metal inspires troops with greater confidence than a gun consisting of several distinct portions."

My process for obtaining ideal perfection in gun-making is to unite, and to use successively, the processes of three very eminent gun-makers, Captain Rodman, Sir Joseph Whitworth, and the late Field-Marshal Baron Uchatius, in the succession in which I have placed their names. Thus the process of each is improved by, and helps the other, and what could be conceived more admirable than one of Sir Joseph Whitworth's ingots cast hollow on Rodman's system in the form of a gun, condensed by Whitworth, and kept in the mould under his vertical pressure, while still farther laterally condensed from the inside, as it cools, by Uchatius's mandrils, driven by hydraulic power,

up the centre, at a pressure of 200 tons to the inch, and the pressure maintained until the temperature of the entire mass had fallen to that of the atmosphere? No chance of the ears—I beg pardon, the trunnions—blowing off that gun.

The plant required is cumbrous and costly, but tools ought to be proportioned to the work they have to do, and it is obvious that this system of forging a cast steel gun in its mould must ensure a density, thoroughness, and uniformity of working, hitherto only attained in steel wire.

I will conclude by quoting a very apposite passage from a letter I wrote on 29th of October last:—"My ambition is to produce a modern rifled gun of unapproached power, which yet may be treated in the same rough and ready way as were the old cast-iron guns in the great days of the British Navy, when a Captain would lay his ship alongside the enemy and pound away at him quite regardless of the heating of his guns.

"Modern guns built up in pieces are exposed to great danger by the heating due to very rapid firing, and to greater still from the *re-cooling*. . . . Now as the temperature of fired gunpowder approaches twice the melting-point of steel, it has always seemed to me that the temper of tempered guns would necessarily be very soon destroyed by rapid firing, and that consequently any gun, whose efficiency depended on its temper, never could fulfil the above condition which I had set myself to accomplish. Therefore one of the metallurgical problems which I have worked at has been to endeavour by some other process to accomplish the necessary rearrangement of the molecules of steel, one form of which rearrangement is known by the term 'temper.'"

Colonel HOPE: Since writing this paper I have received a communication from the War Office authorizing me to make an announcement, which I think you will hear with as great pleasure as it gives me to make it, to the effect that there is a probability of a *modus vivendi* being arrived at between the War Office and myself.

The CHAIRMAN: I have now to invite discussion upon the interesting paper to which we have just listened.

Captain PENRICE: The experiments mentioned by Colonel Hope were made many years ago, when I was a subaltern in the Royal Engineers. One of the subjects on which I was then engaged was a new propeller, and my attention was drawn to the form of the vessel, and the resistance offered by the water. The best information I could get was from some experiments at Greenland Dock, conducted for the Government by the late Colonel Beaufoy, F.R.S. Various models were fixed to the end of a pendulum and oscillated through water. Unfortunately the velocity was very low. In 1847 I designed a projectile which I considered would attain a much longer range than the spherical shot which we then used. I applied to the Board of Ordnance for a gun, but my application was not successful. I then ordered a very powerful "catapult," 10 feet long, of ten plates of steel, each 4½ inches wide and ¼ inch thick. I fixed this very firmly in a strong cast-iron frame above a canal. Various models, 3 inches in diameter, were then fired from the "catapult" through the water at a very high initial velocity (the same in each case). Their ranges showed the approximate resistance to the different forms. I tried the "solid of least resistance" of Sir Isaac Newton. This varied with the velocity. The paper which I published is, I think, out of print, but, as far as I can remember, some of the results were as follows:—1. The projectile must retain its position on one axis during its flight (this necessitated rifled ordnance). 2. The front end must offer the

least possible resistance to the air. 3. The hind end must fill the "vacuum" left by the front end. 4. The form of that "vacuum" is conical, its length depending upon the distance the projectile travels while the air is filling a circular vacuum of its own diameter. I tried a second series of experiments by fixing various models on a fine steel axis in a large pipe, through which steam was forced at a high pressure, one end of the axis being fixed to a pressure gauge. I also proposed that when the projectile was at its greatest altitude, it should receive a second "impetus" as a rocket, by filling it with rocket composition ignited by a time fuse. I also advocated "muzzle pivoting" and armour plates. I believe that with the great initial velocity to be obtained by Colonel Hope's happy method of igniting very large charges of powder in his new gun, a projectile of the right form will attain a range far in excess of anything hitherto accomplished.

Major MACKINLAY, R.A.: I should be glad if Colonel Hope would give figures about initial velocities and pressures at different parts of the bore obtained in his guns actually fired. I believe experiments have taken place to determine them, and it would be an advantage if he could give us this definite information. Colonel Hope speaks of making a 5-inch gun equal in power to the 38-ton gun. Surely this assumes that the projectile simply acts as a punch. But as modern armour is made now of steel or faced with steel, it appears that such a comparison can hardly at the present moment be fairly made, for it seems to be generally allowed from the result of late experiments that the breaking up of steel-faced plates depends on the total amount of energy which a projectile contains. A large projectile and a small one with an equal amount of energy would produce about the same amount of damage on steel armour, but they would not of course penetrate in the same way into wrought iron, and it would appear that Colonel Hope has made his comparison on the assumption that all armour is composed of wrought iron. As steel-faced armour is now being introduced, I think such a comparison can hardly be made with justice at the present time.

Major ELLIOTT: There can be no doubt, I think, of the correctness of Colonel Hope's theory and principles as to the construction of guns. For a long time past there can be no doubt that the highest efforts ought to have been to get the quickest-burning powder and the strongest form of gun which together will give the greatest amount of initial velocity, so as to get the longest range and greatest smashing power; but it is in the application of his theory where I think Colonel Hope's difficulty will arise. Do I understand Colonel Hope to say that the whole of that long cartridge case is to be of steel, or is it to be made of flannel?

Colonel HOPE: A thin steel skin cartridge.

Major ELLIOTT: It is just about that form of cartridge that I wish to ask a question. I observe that the form of the chamber is a cone. I remember when I was at Enfield associated with the manufacture of small arms, and trying experiments with the new Martini-Henry action and also with the Snider, we tried several forms of cartridge chambers in order to get the easiest extraction of the empty cartridge case. The extractor of the Martini-Henry is a lever extractor working on an angle pivot. The first experiment we tried was with a cone chamber. We tore off the bases and flanges of every cartridge one after another. We found that the cause of that was really the form of the chamber. The reason of drawing off the ends of the flanges of the cartridges was, that the powder gas was driven with such terrific force up against the fore end of the cartridge, that it jammed it right up against the front part of the chamber, so that it was absolutely impossible to extract the empty case. It appears to me that Colonel Hope will find himself before long in a difficulty in adapting the cone form of chamber to the solid-drawn form of cartridge. If an action as just described takes place in a small piece like a rifle, it will occur with ten thousand times more violence in a long chambered gun similar to the plan before us; and it strikes me that if Colonel Hope perseveres with that cone form of chamber, he will find the effects of the explosion will drive the inner part of the fore end of his cartridge with such fearful jamming weight up against the fore end of the chamber, that he will not be able to extract the empty cartridge case. Another point is that of the extractor. It does not appear to me to be clear how Colonel Hope is going to make his extractor get a long cartridge case out of the gun. It will require some very powerful and severe leverage to get it out of the

chamber. I think if Colonel Hope can overcome these difficulties in the practical application of his theory, his principle is correct. It is in overcoming such mechanical difficulties as these that he will bring his theory to a practical result.

Admiral SELWYN: I hail with great pleasure Colonel Hope's paper, because I think it is one of those which this Institution wants more than anything else—a protest of common sense against theory falsely grounded. He has very properly said mathematics are beautiful things if you could only always be certain that you were using them correctly, but the introduction into the total function of one factor which happens to be a little in error vitiates the whole conclusion, and that has been done over and over again. It is always being done unfortunately, and when people so speak, they do not only form false conclusions, but their eventual results are always vitiated by those original false conclusions. Given a desire to drive a projectile as far as possible, we must do it, say the practical persons of the present day who have charge of it, by using a very bad powder fired out of a very clumsy gun. Now if they were shown this as a result, they would at once acknowledge it as an error from the beginning; but built up from the theory, they are inevitably brought to this conclusion by the force of each error in their argument. This paper, I say, is a very strong protest in favour of adhering to common sense, and I hope that what Colonel Hope tells us in his own case may very speedily be brought to pass. While I admire very much his explanation of the theory of the pressure set up in the chamber by the ignition of powder as it must necessarily obtain in the case of bad powder, I venture to doubt whether in the case of the very best powder that could be made and used in a very strong gun under proper conditions, those wave pressures ought to be considered as an absolute necessity; but certainly whatever may be the length of the cartridge eventually required, I think Colonel Hope's idea of igniting it at every part of its length is one which must commend itself to every practical man's common sense. You want to produce from a mechanically mixed substance the greatest amount of gas in the shortest possible time; what you do, is to produce only that amount of gas which can be given off by the area open to the first ignition due to the discharge at the vent. Now we may consider in a long cartridge the powder in front of the first gas produced as a spiral spring. If the grains of powder be compressible, then it must use up some force in order to compress them, and therefore it has in some of its aspects a distinct relation to the existence of a spiral spring in the powder which is pressed up. The spiral spring, if so pressed up and then subjected to a difference of pressure, due to the starting of the projectile, would inevitably give out the portion of that spring first communicated to it in the reverse direction. It would begin to press back the original gas or spring force applied. If we could conceive such a thing—I take a spiral spring because it is more possible to communicate the idea through that image—if you take a spiral spring and press it up until it moves something in front, the instant that motion takes place that instant the spiral spring is relieved of a portion of the pressure, and it exerts itself equally in both directions; it exerts itself backwards against that which presses it from behind, as well as against the resisting body in front; the action in the case of the powder has been to compress the grains into granules, to make the next portion of the powder stronger, because more quickly oxidizable than what was previously ignited under the mere action of the vent. Thus we get another element introduced which increases the intensity of the action of the spiral spring; the wave pressure is again set up; it again opposes the gas behind, and is relieved by forcing forward the projectile, and thus in this case unless you do ignite the power from end to end at the same time there always must be a set of wave pressures set up which will be notoriously influenced by the heating of the gun, and which at the same time, as Colonel Hope says, create a danger to the gun. Having said this much, I venture to dissent altogether from the idea which has been put forward that the conical cartridge case is difficult to extract. It must be one of the easiest things possible; but if you make that cartridge not out of solid material, but of every kind of thing stuck together with shellac, I do not wonder that the wretchedly ill-attached base pulls off, as no solid-drawn cartridge, such as we see in the present day, ever does. We have got in the torpedo guns up to a very large size of metallic cartridge. That cartridge is coned and shouldered; there never is the smallest

difficulty in withdrawing it. It is perfectly coned and shouldered with a proper solid attachment at the base, and presents no difficulty whatever in action; therefore I dissent from the idea that a metallic cartridge, which is unmistakably a lining for the gun, and therefore extremely useful in preventing the scoring action, if it can be carried out in the larger gun without an undue unhandiness, will be anything else than a very material feature in prolonging the life of the gun. We may, as was said in Colonel Maitland's paper, reduce the weight of the gun to such an extent that the recoil becomes a very serious element to deal with; and the difference in the weight of a 38-ton gun, with a superior velocity of projectile and superior energy in the 5-ton gun, would bring that question very prominently forward. It is not a thing which should be neglected, and we must determine what means we propose to use by which the whole energy and recoil may become an advantage instead of a nuisance. It is quite possible that Colonel Hope may see his way towards employing something of the kind adopted by Colonel Moncrieff, but resisted whether by hydraulic buffers, or by strong indiarubber springs, or by immensely heavy carriages, I should say it was likely to prove a very difficult problem. Intelligently resisted, as is done in the Moncrieff carriage, I think it is quite easy of solution. With regard to the question of internal barrel, the material for resisting any impact, such as powder gives, is certainly not any other kind of steel but cast steel, and that very hard cast steel. We ought to get that which we are seeking to gain from temper by a proper arrangement of the molecules of the steel either in casting or making a tube. I confess there seems to be an enormous future for the wire-gun principle, because we get by wire construction a greater tensile strength than that of cast steel made by any method whatever. With regard to the question of transmitting the longitudinal strain, which is never a very serious one, and converting it all into radial pressure, there is no person better able to speak than Captain Penrice. It is many years ago when, at Corfu, we met, when he was using three metallic wedges with only a musket charge to blast the rocks at Vido, which could not have been done with certainly three or four times the quantity of powder had he not adopted that plan. I am quite sure that the same thing can be done with the wire guns, that you can convert the whole longitudinal strain into direct radial strain without any difficulty. It seems a very extraordinary expedient, but I believe Captain Penrice will tell us he never found one of his wedges blow out. It is a very curious fact that if you strike a percussive blow on the base of a wedge, you certainly do transmit the whole radial strain, but you do not necessarily jam the wedge. A child can release by a pull that which the whole force of powder exerted in a large gun cannot blow out by percussive action. With regard to the armour plates, I think it is a mistake in the present day to talk of any projectile as perforative; we must consider it entirely with the modern armour plate construction, that the steel facing, though it is not yet done as I should like to see it done with a due regard to the forces at work, the transmission of molecular energy in a direct cone of dispersion, that is not yet done, it is done in a very rough and ready way, but it has produced enormous effects. But here we are now getting the question of perforation entirely done away with. All you can do is to break up a plate after a time. It will transmit the strain due to the point of the shot striking the armour plate in the cone of dispersion which finds its limit based on the whole structure of the ship, and eventually I might say almost in the body of the ship; if there were force enough it would tend to move the whole body of the ship. I would ask Colonel Hope to consider whether that projectile is one with which he could hope to produce good effects on steel-faced armour. I think not. I think he would find the heels of the shot would have a tendency to burst out directly the point struck, and therefore he would not consider that a good armour-piercing projectile. The length of gun beyond what is absolutely necessary to get the results required, is a distinct evil to us in the navy; the longer the gun, the more unhandy it is on board ship. In many ways, even in turrets, this is felt very strongly, but whenever we come to arming ships as they ought to be armed with the number of guns proportionate to their total tonnage, we shall find it still more difficult to deal with them on the broadside. I hope that we shall all benefit in both Services by Colonel Hope's common sense endeavours to produce for us the best gun.

Colonel HOPE, in reply, said: Major Mackinlay asked me if I would give any

figures as to initial velocity and pressure. I am sorry to be obliged to refuse, but I must do so for this reason. I invited the Ordnance Department to send two Officers to witness my trials, and I offered to pay the whole of the expense on one single condition, that condition being that I should be allowed to have a copy of their report. That was said to be impossible, so then I said it would be enough for my purpose if I might *see* the report. I did not wish to possess it, it could have no possible value for me, but it might very likely contain errors, and it was to guard against those errors that I wished to see it, and therefore I asked permission to be allowed to sit down in the War Office to read it, and if necessary write a correction then and there, keeping a copy of neither, as I had been allowed to do on a former occasion in another case. I gave them a precedent, because of course everything goes by precedent in the Ordnance Department. But that suggestion also was refused, on the ground that the document would be confidential for the eye of the Secretary of State only. I said it could only possess greater value for the Secretary of State if it had passed under the eye of the inventor, and he had found no error in it, or had corrected the error if it had contained any; and that was not a legitimate reason; and I said I knew perfectly well that no gun which would create such a revolution as this gun could possibly be introduced into the Service on the strength of any mere secret report, and moreover that there was not the slightest occasion for any secrecy; on the contrary, let us have broad daylight, and plenty of it, and that therefore if they insisted on keeping everything secret, they should not see the experiments at all; and I am afraid I must stick to that. As they would not allow me to see their report, so I shall not allow them to see the results of my experiments. But it is of comparatively small consequence, I think, inasmuch as I do not ask them to take one single penny of risk. I take the entire risk, and the experiments were sufficiently satisfactory to justify me and those behind me in taking that risk. The gun that I made in France is a facsimile of this gun except at the breech, and is a foot shorter because it has a French breech—a cork stuck in a bottle, instead of my breech. All I will say is that the velocities with long heavy shot have been higher than those of any other gun in the world, that the pressures have been higher than those of any other gun in the world, but that they have not been excessive, and that the gun has not burst. With regard to steel-faced armour, this gun of course has a disadvantage in respect to the weight of the shot. The weight of this shell is only 100 lbs., whereas the weight of the shell of the 38-ton gun is 818 lbs. But this gun could be carried on board a passenger steamer, taken up suddenly in time of war, whereas you would have to spend four years in building a large ship round your 38-ton gun before you could send it to sea. And to take things in their natural sequence I may add that if I made a 30-ton gun the total energy of that would be vastly greater than the total energy of the 38-ton gun, and the energy per inch of circumference of projectile would be no less than 1,200 foot tons as against 720, which is the energy per inch of circumference of projectile fired from Sir William Armstrong's 110-ton breech-loading gun. Thirty tons as against 110, 1,200 as against 720, and if ever I found a Government willing to allow me to make for them a 12-inch gun 46 feet long—if Admiral Selwyn will allow me to have such a length—and 100 tons in weight, then the energy per inch of circumference of projectile of that gun would be upwards of 3,000 foot tons, and I undertake to say that any ship in the world would have to go to the bottom before it. As regards the question of recoil, I am happy to say a prophecy which I ventured to make before I ever fired my gun has turned out strictly true. I said the recoil would be less with my gun than with any other, and for two reasons. First, the cartridge in the little gun contains enough powder to overcome the inertia of the shot, to move it forward one calibre, and to cut the rifling into the rearmost Vavasseur soft copper ring. The front ring does not take the rifling sufficiently to make the shot rotate, merely enough to centre it truly. Therefore the first resistance of the shot is overcome by a little puff of powder, say three quarters of a pound in a 5-inch gun, which is not sufficient to produce any appreciable effect on the gun itself. Then when the large charge of powder goes off, the inertia and the worst of the friction having been overcome already, the large charge of powder operates on a moving body, and does not operate so enormously on the gun; it finds a way of escape ready made for it, and goes out, and the

largest recoil I have had on a rough timber carriage, a perfectly unchecked recoil, has only been 1¾ metres. The second reason is the great weight of the gun in proportion to the shot, owing to the proportions of everything being radically changed. Therefore I do not anticipate any trouble in the matter of recoil. As regards the question of the coned cartridge, I have an arrangement for preventing the bad effects which my friend Major Elliott is afraid of, but it would take rather too long to describe it. You will see on the diagram the extreme rear of the cartridge is shown in elevation, and you see there is a very thick rim of solid steel, and if that is not thick enough I can very easily thicken it, because that part of the gun is doing very little work, and I can very easily prolong that thick rim another half or three-quarters of an inch until I make it thick enough and strong enough to bear the blow. Then the steel extractors C D are, as you see, very strong, powerful things, and ⅝ of an inch thick. When the gunner puts a 6-foot handspike into the socket F, and swings the breech-block open, the shoulder A strikes the short arm E a very severe blow, and I anticipate that there will be very little difficulty in starting the cartridge. Furthermore, it will be well oiled and so forth when put in, made very accurately, sufficiently thick and strong to bear rough usage, and I do not think we shall have any trouble. With regard to the penetration of armour plates, I imagine one must produce a gun that will penetrate the most powerful plate that can be brought to bear against it, and I do not in any way wish to shirk steel-faced armour. I have even invented a special armour myself to endeavour to resist my own gun.

The CHAIRMAN: I am sure you will empower me to return our thanks to Colonel Hope for the interesting lecture he has given us to-day. The information which he has put before us in the first place is valuable, as he tells us that the War Office is about to experimentalize upon the ideas which he has put before them, and I trust that we shall hear a satisfactory result of those inquiries. There is no doubt it must be a great advantage both to the army and navy if a gun of 6 tons weight can be found to perform the duty of one of 38 tons. We know how the 110-ton gun is viewed with some alarm, and how it is feared that if larger guns are made, they will become quite unhandy; but if a gun of 20 tons weight is able to perform the duty of the 110-ton gun, then, seeing that Colonel Hope has placed before us the possibility of making such a gun himself, with proportionate results to those obtained by his smaller guns, we shall have a prospect of obtaining powers which will far transcend anything that can yet possibly be imagined. It is not for me to express any opinion as to the probable results of Colonel Hope's endeavours, but I sincerely trust and hope that he may succeed.

Wednesday, November 26, 1884.

ADMIRAL SIR EDWARD G. FANSHAWE, K.C.B., in the Chair.

WHAT ARE THE MOST URGENT MEASURES THAT SHOULD BE TAKEN FOR INCREASING HER MAJESTY'S NAVY?

By Sir EDWARD J. REED, K.C.B., F.R.S., M.P.

LEST it should be thought that I had proposed to myself the imposing task which the title of this paper sets forth, I desire to state thus early, that the Council of the Institution selected the above subject, and did me the honour of inviting me to undertake its consideration. To respond to this invitation seemed to me a matter of public duty.

I will lose no time in avowing that, in my opinion, no unofficial person can do full justice to the subject, for the reason that no unofficial person can be fully acquainted with those more immediate demands upon the Naval Service which arise out of our existing foreign relations, and respecting which even the Board of Admiralty itself have to be somewhat guided by the Foreign Office. But the object of the Council is not, I feel sure, to have the subject which they have set before us discussed in minute detail, but rather to have brought into view, in the first instance by myself, and subsequently by those Officers and gentlemen who may take part in the debate, the general and most urgent requirements of Her Majesty's Navy at the present time. Most persons agree that special and considerable measures should be resorted to, but there is much less agreement as to the nature of those measures, and the Council doubtless desire to have a timely and influential discussion upon the matter, with the view of aiding the solution of this great national problem. As there is no Institution in the country more capable than this of assisting that solution, I will do my best to open the debate in a manner not altogether unworthy of the Institution and of the occasion.

I propose to address myself to this task under the following headings:—

I. Armoured line-of-battle ships.
II. Unarmoured auxiliaries of line-of-battle ships.
III. Armoured cruizers.
IV. Unarmoured cruizers.
V. Torpedo-vessels.

It will be observed that this leaves out of consideration several subjects which have recently and deservedly engaged much public attention, viz., those of coaling stations, of the employment of mercantile ships for war purposes, of armaments, and of the condition of the boilers of Her Majesty's ships. These are omitted because they are not properly covered by the title of this paper, and that which the title does cover seems ample for the purpose of the present discussion. I also assume that it is to the *matériel* and not to the *personnel* of the Navy that we are at present to address ourselves.

As the very first measure which I should advise would be the rapid completion of all the new ships at present in hand, I propose, before entering upon either of the above divisions, to say a few words upon this subject. I know of nothing more unfortunate than the excessive length of time occupied of late years in the building and completion of our ships. This may be accounted for in many ways, but there is one cause for it which is seldom assigned, viz., the fact that its importance is not properly and clearly understood by those in authority or by others. The annual waste of public money due to this cause is so great that, if Parliamentary economists realized it, the outcry would be so loud as to terminate what is little less than a public scandal. Let us look at a few figures illustrative of this.

In dealing with the matter I shall assume—what probably no man of business or of sense will question—that capital invested in a ship, a dock, a house, or any other such object is capital upon which interest is being lost all the time the object is under construction, and remains unfit for use; and the usual and ordinary course, in estimating the real cost of such a thing, is to add to the outlay the interest upon the money invested until its completion. Upon this correct and business basis I shall proceed.

I will next lay it down as a fact, which certainly no private shipbuilder in the country will controvert, that three years is abundant time for the construction of the largest ironclad ship that is ever built. I am sure I should be generally supported if I were to name a less period; but I say three years in order to avoid reasonable questioning. Of course I am aware that if you delay the manufacture of the armour, or of the guns, or of any other part of the finished ship which takes much time for its production, until the hull is well advanced, you can defeat the object in view; but common skill and attention only are needed for building and finishing in three years the most powerful ironclad ever yet produced. But instead of three years, the average time now taken for the construction and equipment of Her Majesty's armoured ships is more nearly six years than three. Several ships have been in hand for more than six years, and some for much more. But long as the avowed time of construction and completion often is, even that falls greatly short of the actual time. As an example of this we may take the "Conqueror." In the Navy Estimates for this year we were told that the "Conqueror" would be fully complete by March last, and that nothing would remain to be done at that date. This statement was repeated officially in Parliament. But now we are told, also officially in Parliament, that

although eight months beyond that date have elapsed, the country is still to wait several months longer for the use of this ship. Now the "Conqueror," with her machinery, armament, &c., has probably cost over 400,000*l.*, and the public loss by this one year's delay upon that sum at 5 per cent. is 20,000*l.* As she has been five or six years in hand, and has long been in an advanced state, it is probable that a sum of 40,000*l.* to 50,000*l.* in all has been lost in this manner by the delay of this one ship, although she has not been so long under construction and completion as many others.

It will be instructive before proceeding further to show in the following manner the general financial consequences of long delay in building ironclad ships. We will presume the actual outlay upon the material and labour employed in building the hull of a given ship in a Royal Dockyard to be 500,000*l.*, and the price of her machinery to be 100,000*l.*, making a total of 600,000*l.* We will further presume that interest at the rate of 5 per cent. is to be allowed, and added to the actual outlay, at the end of each financial year. (Lest 5 per cent. should be considered too much, as the Government obtains funds at a much lower rate, I would observe that, in a correct account there would have to be very large additions made to the actual outlay on hull and machinery, such as establishment charges, cost of armament, and armament fittings, &c., and no lower rate of interest would at all fairly represent the facts.)

We will take, as our first case, that of both the ship and machinery being completed in three years, and paid for in three annual instalments. We shall in this case have:—

	£
1st instalment	200,000
2nd instalment	200,000
Interest on 1st instalment	10,000
3rd instalment	200,000
Interest on 410,000*l.*.....	20,500
Total cost to the country	630,500

We will take, as our second case, that of the same ship, but with machinery completed and paid for in three years, by three equal instalments, while the hull, making uniform but slow progress throughout, occupies six years, and is paid for in six equal instalments. For convenience we will here separate the payments for the hull and the machinery. We shall have:—

Cost of Hull.

	£	£
End of 1st year, 1st instalment $\frac{1}{6}$th of 500,000*l.*	83,333	
„ 2nd „ 2nd instalment	83,333	
„ „ „ interest on the 1st instalment.		4,166
„ 3rd „ 3rd instalment	83,333	
„ „ „ interest on previous investment		8,541
„ 4th „ 4th instalment	83,333	
„ „ „ interest on previous investment		13,135
„ 5th „ 5th instalment	83,333	
„ „ „ interest on previous investment		17,958
„ 6th „ 6th instalment	83,333	
„ „ „ interest on previous investment		23,023
	499,998	66,823
	66,823	
Total cost of hull.....	566,821	

Cost of Machinery.

	£	£
End of 1st year, 1st instalment	33,333	
„ 2nd „ 2nd instalment	33,333	
„ „ „ interest on 1st instalment		1,666
„ 3rd „ 3rd instalment	33,334	
„ „ „ interest on previous investments		3,416
„ 4th „ „ „ „		5,254
„ 5th „ „ „ „		5,516
„ 6th „ „ „ „		5,792
	100,000	21,644
	21,644	
Total cost of machinery	121,644	
Total cost of hull	566,821	
Total cost of ship	688,465	

Here we see that the cost of the ship to the country has been increased by no less a sum than 58,000*l.*, owing to the fact that she has been allowed to occupy six years in building and completing instead of three years.

The case is still worse if we take into account the long delays which are permitted to occur after a ship is all but complete, when nearly the whole outlay upon her has been expended (which is the present case of the "Conqueror"), and she is kept in a state of uselessness, as is sometimes the case for a year or two. If, for example, the ship which we last considered had her final completion further prolonged, say for a couple of years, by the want of gun fittings or other matters which do not enter into the price which we have considered, her cost

to the country would be raised, by interest lost, to 759,000*l.*, and the total loss to the country by delays upon this one ship would be no less a sum than 128,500*l.*, or 98,500*l.* unnecessary loss by delay upon an outlay of only 600,000*l.*

If we select actual ships, the matter sometimes bears this aspect, or a worse. The "Edinburgh" was actually laid down in March, 1879, and will therefore have been six years under construction on the 31st March next. The sum of 456,300*l.* will have been spent upon her and her machinery (without guns) during those six years. On the 31st March, 1883, this ship had been four years under construction, and about 420,000*l.* had been expended upon her, besides a loss for interest of at least 15,000*l.* The loss upon the investment for the financial year 1883–84, at 5 per cent., was therefore 21,750*l.* The expenditure during that year was estimated by the Admiralty at about 43,500*l.*, bringing the outlay upon her, including loss of interest, up to 500,250*l.* on the 31st March of this year. The estimated expenditure upon her for the current financial year is 21,000*l.*, and the loss of interest during the year 25,000*l.*; so that the total amount which she will have cost on the 31st March next will be 546,350*l.* She will then be only $\frac{73}{100}$ths or less than three-quarters built. To complete this ship by the 31st March, 1886, there must be expended upon her a further sum of 141,000*l.*, and there will be a further loss of interest for the year upon the investment of 27,300*l.*, bringing the total cost of the ship to the nation up to the sum of 714,500*l.* (without armament). The original estimated cost of the ship with her machinery was, I believe, below 500,000*l.*, and before she is finished it will probably therefore have been exceeded by more than 200,000*l.*, of which about 100,000*l.* will have been a dead loss. On the 31st March next this ship, which then will have already cost the country 546,000*l.*, and will have been six years in hand, will be utterly unavailable for any war which may possibly occur, and will remain so for a year or two afterwards.

Again, according to the Navy Estimates of the current year, we shall have unfinished in our several dockyards on the 31st March next the following ironclad ships which will then have been over three years under construction, and we shall at that date (next March) have expended upon them, apart from armament, the amounts placed below against their names:—

	£
"Rodney"	385,700
"Warspite"	411,300
"Impérieuse"	446,500
"Colossus"	590,000
"Collingwood"	466,800
"Edinburgh"	456,300
"Howe"	317,800
	£3,074,400

Here we have over 3,000,000*l.* sterling invested in seven ironclad

ships under construction, every one of which ought to be complete and ready for sea on the 31st March next; but in the official proposals of the Admiralty for the current year it is only suggested that two of the seven shall be finished by that date, and as a matter of fact not even one of the seven will be then completed at the recent rate of progress.[1] The interest upon this investment alone at 5 per cent. will be at the rate of 150,000*l.* *per annum*, and although I have put the rate of interest at 5 per cent., if there were time I could show that the actual loss per annum will be greater than the sum just named. Losses similar in character, but less in amount, are also being largely incurred at present in the case of unarmoured ships, and have been for many years past.

I think I have now shown that from a financial point of view the prompt completion of the ships now in hand should be the very foremost of the measures to be adopted for increasing Her Majesty's effective Navy. There are other points of view from which the necessity for this measure will appear with equal plainness, but to these we have not time now to proceed.

The next urgent measure which I propose to refer to is that of increasing the number of our armoured line-of-battle ships. And here I encounter a preliminary difficulty of the most serious nature. It will be present to the minds of most of those who hear this paper read that I am not an admirer of our recent ironclad ships, in nearly all of which the armour-belt is limited to about one-third of the ship's length. When, however, the "Inflexible" question arose there were so many naval Officers who expressed confidence in such ships, including nearly all the naval Officers holding official and highly responsible positions at the Admiralty, that I have not since felt it necessary or desirable to further press my views or apprehensions. If naval Officers after full warning are satisfied to have two-thirds of the ship's length stripped of all armour, and if they consider a ship so circumstanced (if supplied with exposed cells and inner belts of cork) suitable for the line-of-battle, well and good. I do not propose, here and now, to question their judgment. I will say nothing whatever adverse to such ships, of which there are now so many built and under construction. But what I do wish to point out is that it is surely impossible to regard such ships as the equals of those French ships which have *equally thick armour*, but with belts extending from stem to stern. Supposing you have a ship protected from stem to stern with 12-inch armour, and you say, I prefer to give up the belt altogether for 100 feet forward and 100 feet aft, and put, say, 16-inch armour over the central 100 feet only, I can perfectly understand that, and I can also understand your comparing your new vessel which has 16-inch armour on the midship part only, with the other ship of 12-inch armour and a complete belt; but what I cannot understand, and what is certainly as contrary to common sense as it is dangerous

[1] I am informed that the "Colossus" will really be ready for sea in every respect by the 31st of March next. It is just possible, but if so, she will certainly be the only one ready of the seven ships above-named.

FIG. 1. COLLINGWOOD.

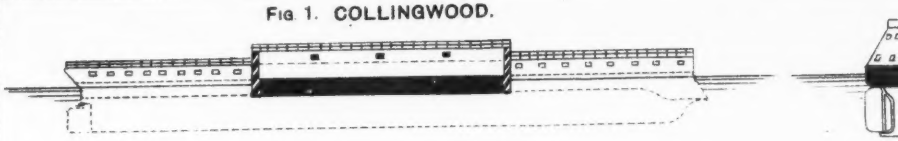


FIG. 3. COLLINGWOOD.

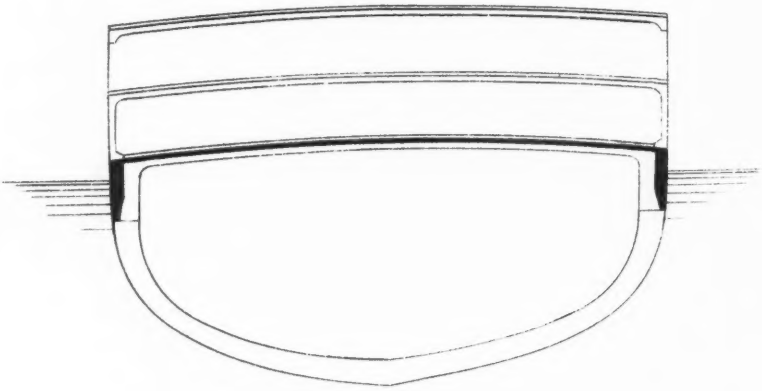


FIG. 5.

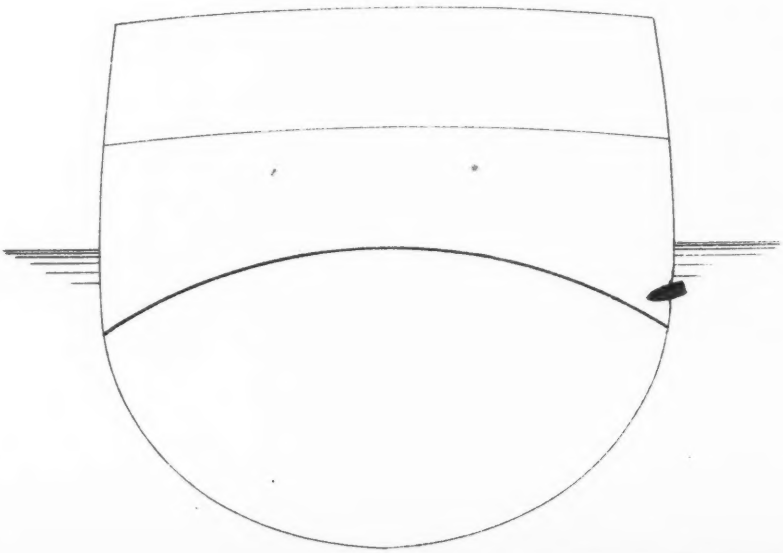


FIG. 2. AMIRAL DUPERRÉ.

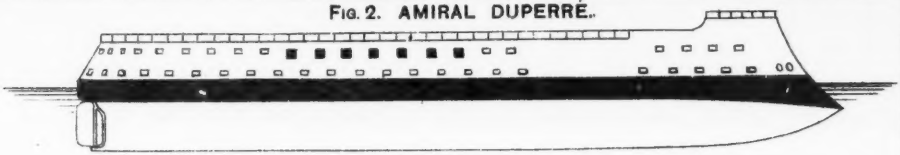
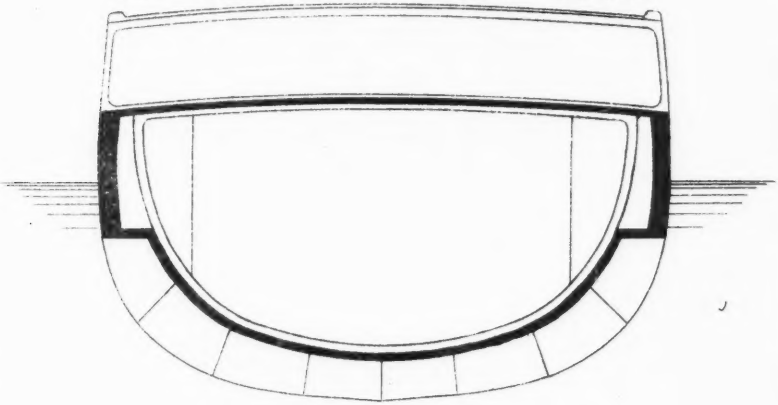
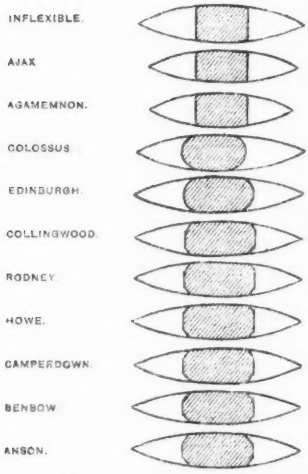


FIG. 4. ARMOUR-CLAD, WITH TORPEDO DEFENCE.

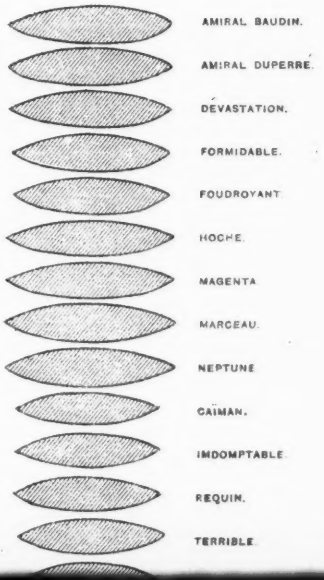


SHIPS WITH 15 INCH ARMOUR AND UPWARDS.

ENGLISH.



FRENCH.



to the Navy, is that when you have only got the 18-inch armour over 100 feet of length, you should imagine that your ship has the same armoured tonnage as another which has *the very same thickness of armour amidships, and yet has a complete belt.* This is a most serious matter, which some may regard as vitiating and overthrowing the whole of Sir Thomas Brassey's recent comparisons between the English and French armoured fleets, and many other comparisons which have been made.

The armour having been stripped, so to speak, off two-thirds of the English ship's length at the water-line, in order to secure a *thickness* equal to that of the French ships, Sir Thomas Brassey then makes the thickness alone the standard of comparison. Fig. 1 is a side view of an English ship, say the "Collingwood;" Fig. 2 is a side view of a French ship, say the "Amiral Duperré" or "Amiral Baudin;" Fig. 3 is a midship sectional view, which will serve for both the English and the French ships. The armour may be taken for the purpose of this argument to be of the same thickness in all cases. (As a matter of fact the "Collingwood's" belt amidships is 18 inches thick, the "Amiral Duperré's" $21\frac{6}{10}$ inches, the "Amiral Baudin's" 22 inches.) I find that as a rule the displacement tonnage which is protected from above by the belt and the thick deck at the top of it in the English ships is less than one-half of the displacement tonnage of the ship, whereas in the French fully-belted vessels the whole displacement is, of course, protected. Yet Sir Thomas Brassey, in his comparisons with the French Navy, treats the whole tonnage of the "Collingwood" and of all such ships as armour-plated tonnage, and compares it with the total tonnage of the French ships which are really armour-plated throughout. I find it impossible to account for so extraordinary a proceeding, which, if not promptly corrected, may be fatal to the naval security of the country.

In the English ships there is, I know, a stout deck 6 or 7 feet below the water, and this protects the displacement below that from penetration by shell-fire; there are also cells and cork chambers (but all exposed to fire) above that thick deck at the ends. But underwater decks, and cells and chambers above them, are the characteristics of unarmoured ships and not of armoured ships, and they may be making a terrible mistake who first make the thickness of armour on the belt amidships the standard of comparison between English and French ships, and then reckon the whole tonnage as armoured tonnage, whereas about one-half (generally more than one-half) of the English ship's tonnage is entirely devoid of the protection of side-armour. This is, perhaps, as serious a question as any which the naval authorities of this country have to consider, and I would express the hope that in the discussion which will follow this paper naval Officers will be good enough to state their opinions upon it. Let them clearly understand I am not here objecting to the building of ships with very limited citadels if they prefer that kind of ship, but only to the reckoning of the unarmoured parts as armoured. My reason for mentioning this at some length is the direct bearing which it has upon our subsequent estimate of the present strength of our armoured

navy, and consequently upon our estimate of the number of additional ironclads which we require, as we shall presently see.

One other remark, having a like bearing, I wish to make. I do not think it safe to keep so far in the background as some persons have kept them, several very powerful ships building in France, and to keep them back on the ground that they will not, it is thought, be complete in 1886; especially should we not do this while we at the same time put down as certain to be finished in 1886 ships like the "Edinburgh," which will not be three-quarters built on the 31st March, 1885. It will be wiser and safer to err rather on the side of crediting the French with greater despatch, and of doubting (after the experience we have had) whether it will not be the English ships that may be found unexpectedly in arrears.

And here, I trust, I may make still one other general remark bearing upon this subject. What we have to fear is not only the actual preponderance of France, or of France and another Power or two combined, in actual war, but also the great temptations which we put France under to become troublesome and threatening in its policy towards us, should the French once be allowed to know and to feel that we have become too weak on the sea to properly assert our rights there if necessary. This is a view which some good and amiable men will readily enough denounce, ostensibly in the interests of peace and international good fellowship. But States are not swayed by friendly sentiments alone, and while I would never advocate such an extension of our naval power as would excite antagonism, I for one am perfectly certain that the most compromising and most dangerous policy which England can possibly adopt, and the one most certain to invite war and all its losses and sufferings, is the policy of allowing other Powers to think meanly of us as a naval nation. We have at the present moment a Government that strenuously deprecates war, and endeavours to avoid war everywhere, but which is not on that account able to keep the country out of war, or to avert the sending forth of numerous armed expeditions. A policy of peace in Europe to be effective must, with us, ever be associated with ample naval power.

In considering what additional armour-clads we require to lay down, it will be necessary to take note of the French armoured navy, and here again I am, with much regret, unable to concur with Sir Thomas Brassey. Sir Thomas takes armour of 9 inches and upwards, and ships of a displacement of 8,500 tons and upwards, as the criteria of comparison; he assumes that we shall complete the "Edinburgh" by 1886; and he further assumes that a number of powerful French ships, which he described three years ago as under construction, will not be finished in 1886. Sir Thomas further—in his speech at Hastings on the 21st October—while very properly pointing out that the French are obliged to build new ships to replace the decayed wooden ironclads, failed to attach sufficient importance to the fact that they are so replacing them by ships of the newest type, with the thickest armour, and the most powerful guns.

Now I need hardly say that it is from no desire to oppose myself

to Sir Thomas Brassey, whom I esteem so highly, whose genuine interest in the Navy is so great, and whom I would here heartily congratulate upon his advancement at the Admiralty, that I find it necessary to put the case very differently from his presentation of it; if I do so, it is because the question is of such vast importance that in its discussion we are bound by the most solemn obligations to look the facts in the face, and to look at them with no ulterior object to strain our judgments.

Now it seems to me very misleading to fix upon armour 9 inches thick and upwards as the criterion of comparison, as Sir Thomas does, because it admits a great many elderly English ships which cannot be fairly compared with the modern French ships. It is equally wrong to fix 8,500 tons as the lowest limit of tonnage, seeing that we thereby exclude several extremely powerful French armour-clads of recent date which exceed 7,000 tons of displacement, as we shall presently see. It is equally wrong to take it for granted that the French will only complete two, seeing that the French have several other ships which have been in hand for some years, and were described by Sir Thomas Brassey himself three years ago. And, as we saw earlier in this paper, it is most wrong to reckon in armoured tonnage the whole displacements of ships more than one-half of which displacements are altogether without armour on the side.

Sir Thomas Brassey well said that "classification is difficult" in comparing ships, but perhaps I may be allowed to adopt what seems to me a fair basis, for a first approximation, viz., the thick armour employed since I left the Admiralty, leaving out of consideration for the moment all the ships of my design. As fourteen years have elapsed since my retirement, we may, I think, fairly call all the Admiralty ships of my design ships of old date (not by any means obsolete ships, however), and ships possessing thicker armour than any of my Admiralty ships may, I think, fairly be called ships of recent date. As my thickest armour was 14-inch armour, I will, therefore, see how we stand, in comparison with France, as regards ships carrying 15-inch armour and upwards. In doing this I will not prophesy anything as to dates of completion, since not only prophecies but promises, and not only promises but pledges, and not only pledges but printed official engagements with Parliament, all fail in this country to guarantee completion, and may possibly fail equally on the other side of the water. I will, therefore, take all ships "Built and Building" with armour of 15 inches and upwards. Further, I cannot accept the designation of "Coast Defence," which the French Government apply to some of their very powerful ships. It is all very well for them to so call them, but where they are ships of over 7,000 tons, or even over 5,000 tons, there can be no doubt whatever that in the event of a war these powerful ships would be sent out against our Mediterranean and Channel Fleets. Premising these things, all of which will, I doubt not, commend themselves to the judgment of the practical Officers present, I proceed to the comparison promised.

Recent French Ships with Maximum Armour of at least 15 *Inches, built and building.*

Ship's name.	Maximum thickness of armour.	Displacement tonnage.
"Amiral Baudin"	22 inches	11,141
"Amiral Duperré"	22 „	10,486
"Dévastation"	15 „	9,639
"Formidable"	22 „	11,441
"Foudroyant"	15 „	9,639
"Hoche"	$17\frac{3}{4}$ „	9,864
"Magenta"	$17\frac{3}{4}$ „	9,864
"Marceau"	$17\frac{3}{4}$ „	9,864
"Neptune"	$17\frac{3}{4}$ „	9,864
"Caïman"	$19\frac{5}{8}$ „	7,239
"Indomptable"	$19\frac{5}{8}$ „	7,184
"Requin"	$19\frac{5}{8}$ „	7,184
"Terrible"	$19\frac{5}{8}$ „	7,184
"Furieux"	$19\frac{5}{8}$ „	5,695
Total		126,288[1]

Let us now turn to the English fleet, and inquire what we have to set against the above fourteen extremely powerful French ships, built and building, of an aggregate armoured tonnage of 126,288 tons.

It is, of course, not possible, without deceiving ourselves and incurring serious danger, to include in armoured tonnage more than the armoured portions of the English ships, and in order that the side-armour of the English ships may have its full value assigned to it, I will assume that the full midship section of each ship is continued throughout the extreme length of the citadel. The long unarmoured bows and sterns form no part of the side-armoured tonnage of the ships which alone we have to compare with the French ships. The following figures are as near as I can give them, most of them being taken either directly from Sir Thomas Brassey's book, or based upon the information there given. We have *eleven* English ships, built and building, with armour 15 inches thick and upwards, to set against the French *fourteen*.

[1] I observe that in the "Pall Mall Gazette" table of particulars of the French ironclads, published on the 17th instant, the "Furieux" is credited with only 13-inch armour; but in the French official "Carnet de l'Officier de Marine" she is said to have armour of 50 centimètres = 19·68 inches, and upon that authority I rely.

These figures are taken partly from Sir Thomas Brassey's work on the Navy, published nearly three years ago, and partly from French official works.

From the above list are excluded the "Brennus" and the "Charles Martel," as although they have been ordered, there is a doubt about their having been commenced.

I have not made any deduction from the French tonnage on account of the armour at the bow being somewhat thinner than the armour amidships, because I find that even at the bow seven of the French ships have armour exceeding in thickness my standard of 15 inches, and there are only two or three exceptions to the armour there nearly reaching that standard.

Name of ship.	Maximum thickness of armour.	Approximate displacement tonnage protected by armour on the sides.
"Inflexible"	24 inches	5,210 tons.
"Ajax"	18 ,,	4,160 ,,
"Agamemnon"	18 ,,	4,160 ,,
"Colossus"	18 ,,	4,580 ,,
"Edinburgh"	18 ,,	4,580 ,,
"Collingwood"	18 ,,	4,580 ,,
"Rodney"	18 ,,	4,800 ,,
"Howe"	18 ,,	4,800 ,,
"Camperdown"	18 ,,	4,900 ,,
"Benbow"	18 ,,	4,900 ,,
"Anson"	18 ,,	4,900 ,,
Total		51,570[1] ,,

The total displacement of these eleven English ships, including the part of their tonnage which is without the protection of side-armour, is 105,030 tons; but if we take the actual armoured tonnage as I have reckoned it, the French have, built and building, 74,000 tons of armoured displacement tonnage, with armour of 15 inches, and upwards, in excess of ours, or $7\frac{1}{2}$ first-class modern armour-clads in excess of our number. If any one should be so infatuated as to reckon the total tonnage of our ships (although the half of it is wholly without side-armour) the excess in favour of the French would be still 21,000 tons, or more than two first-class armour ships.

If there should be any one present who considers that some intermediate figure would be fairer, I for one would be happy to consider that figure, and to learn the grounds upon which he recommends it. I believe the question is one upon which the views of naval Officers who will have to fight our ships in action should be allowed great weight, provided they are pretty generally shared by their brother Officers. The only qualification of my mode of estimating the armoured tonnage that could be claimed with any show of reason would be that of including the end spaces below the armoured decks. There are strong reasons against this, but even this would leave us inferior to the French alone by four or five first-class ironclads of the most powerful type. I presume, however, that the two following propositions will be generally accepted as true:—

1. The British Navy ought to possess some excess over the French Navy in ships armoured with 15 inches of armour and upwards.

2. As British ships no longer are defended by armour-belts from stem to stern, but only over the central portion for about one-third of their length, it is absolutely necessary to make up for this vast deficiency by substantially increasing the number of British ships above that which would be required were the British ships individually equal to the French.

[1] I believe most of the above figures, many of which are necessarily approximate, err on the side of excess.

The inferiority of the British Navy to the French Navy in ships of 15-inch armour and upwards, built and building, as already set forth, is of so serious a nature that it becomes a matter of duty to inquire what relief can be descried by looking somewhat lower in the scale of armour. Let us say in the first place above 12-inch armour, and in tonnage above, say, 5,000 tons of displacement. Within these limits we have the following ships, French and English :—

French.		*English.*	
Ship's name.	Armoured displacement.	Ship's name.	Armoured displacement.
"Redoutable"	8,854	"Dreadnought" ...	10,820
"Fulminant"	5,584		
"Tonnerre"	5,584		
Total	20,022	Total	10,820

Here we see no relief, but, on the contrary, a pronounced disadvantage to the extent of over 9,000 tons, or one large line-of-battle ship.

But now if we go down from this point to ships of 9-inch armour (Sir Thomas Brassey's limit), keeping above the displacement, say, of 4,500 tons (below which we can hardly regard them as more than coast defenders), we shall find the comparison spring up greatly to the advantage of this country. For the comparison between English and French ships carrying armour 9 inches thick up to 12 inches (inclusive), will be as follows, observing that lowering of the tonnage limit to 4,500 tons brings in a French ship or two with more than 12-inch armour :—

French.		*English.*	
Ship's name.	Armoured displacement.	Ship's name.	Armoured displacement.
"Bayard"	5,881	"Devastation"	9,330
"Turenne"	5,881	"Thunderer"	9,330
"Duguesclin"	5,869	"Neptune"	9,170
"Vauban"	5,869	"Conqueror"	6,200
"Tempête"	4,523	"Hero"	6,200
"Vengeur"	4,523	"Rupert"	5,440
		"Hotspur"	4,182
		"Alexandra"	9,490
		"Sultan"	9,290
		"Superb"	9,100
		"Hercules"	8,680
		"Belleisle"	4,830
		"Orion"	4,830
		"Nelson"	6,000[1]
		"Northampton	6,000[1]
		"Shannon"	5,000[1]
		"Téméraire"	8,540
		"Impérieuse"	5,000[1]
		"Warspite"	5,000[1]

[1] Approximate.

Having excluded the "Brennus" and "Charles Martel" on the ground of their non-commencement, the new "Hero" has to be excluded on the same ground. I exclude the "Glatton" also, as she is a mere harbour defence vessel.

It will be seen from what has gone before, that the conspicuous difference between the two armoured fleets of England and France is, that we greatly exceed the French in armoured tonnage of ships with armour 12 inches thick, and less than that, while France greatly exceeds us in its armoured tonnage of ships with 15-inch armour and upwards. It is in early and in weak ships that we abound, and in tonnage protected by thick armour that the French greatly surpass us. It is quite true, as Sir Thomas Brassey says, that we were building iron ships which we still possess, while the French were building wooden ships which have decayed. But if, while the French are replacing their decayed ships with immensely powerful modern vessels, we are content to go on counting up the tonnage of our undecayed but early and comparatively weak ironclads, we shall be left hopelessly behind, and the very forethought which we exercised a few years ago, by preferring iron to wood, will become our curse. The immense superiority of modern ships with extremely thick armour over these early and thinly-armoured ships is recognized by all.

In view of all the facts, it would really seem that in addition to the ironclad line-of-battle ships now under construction, five armoured ships (not half-armoured, but armoured) of the first-class is the very least number which can be laid down (or an equivalent, and therefore increased, number if an extremely restricted citadel alone is to be armoured); all of them should be supplied with the most effective known defence against torpedoes, and very largely subdivided into compartments.

One method of supplying this torpedo-defence (in conjunction with great subdivision) to which I attach very great value, is indicated in Fig. 4, from which it will be seen that an armoured deck or inner bottom (say, 4 inches thick near the armour-belt, and tapering down to, say, $2\frac{1}{2}$ or 3 inches towards the keel) sweeps entirely underneath the whole machinery, boilers, and magazines of the ship at a considerable distance from the thin plating of the outer bottom. The space between the thick armour bottom and the thin outer bottom is greatly subdivided both transversely and longitudinally. The naval torpedo will be stopped and compelled to explode outside of the outer bottom, and the *débris* of that bottom will be dashed against the inner armour, which will of course be vastly more difficult of penetration by this *débris* than the ordinary $\frac{3}{8}$-inch steel plating which at present is all that separates the boilers, &c., from the outer bottom. Of course ships built with the additional armour defence against torpedoes, shown in Fig. 4, can possess also the same inner thin steel bulkheads as other ships, and also all such protection as nets, screens, &c., can provide them with. A glance at Fig. 4 will show that this system of construction—which works out very satisfactorily as regards weight, &c., in several designs which I have prepared—likewise possesses very great incidental advantages, both by preventing a shell from getting into the ship below the

belt (by glancing it off) and by localizing the injurious effects of ramming.

These five ships which I have proposed would, I must confess, not nearly put us upon an equality even with France alone, in armoured ships of about 15 inches armour and upwards, if we leave the unarmoured parts of our recent ironclads out of consideration, for we have only 51,000 tons of such thickly-armoured ships against the 126,000 tons of France (as we have seen); and even if we allow a much higher value to our vessels than I have done—by calling unarmoured ship armoured ship, for there is no other way—our superiority to France alone would not be more than secured by the addition of these five first-class ships of an average tonnage of about 10,000 tons. The addition of these five ships is, then, the second measure which appears to be necessary. I admit its insufficiency, but, so far as it goes, I regard it as very urgent.

We come next to the unarmoured auxiliaries of our line-of-battle ships. The powerful reason which induces me to advise the construction of this class of ship is the belief that, if Great Britain is to retain its due position on the high seas, its naval actions will have to be fought, not near its own shores, but away from them, and near the shores of other people, where its enemies will enjoy the advantage of employing vessels auxiliary to their fleet. In the Mediterranean, for example, it might be our duty to pursue and to engage a hostile squadron near a port, where the enemy would be able to send out a large number of lighter craft, and more especially of torpedo-boats, to co-operate with its fleet. We ought to be in a position to reply to, and to overcome, such auxiliaries.

The question arises, what type of vessel is the best for this purpose? My answer is, these craft must be torpedo-boat catchers, and torpedo-boat destroyers, and therefore must be extremely fast; they must also be perfectly seaworthy, and they must have machinery defended against the fire of machine-guns. They should be built with ram-bows, and armed with torpedoes and with machine-guns.

A very important question here enters with reference to this class of vessel; should it, or should it not, carry one small shell-gun with which to operate at a distance, or against the shore? I am well aware that many persons will probably reply to this question in the negative, and pronounce against that increase of size and cost which the carrying of even a light gun, with its shell and ammunition, would certainly involve. But I am not at all certain that this would be a right decision for the following, among other reasons:—

1st. The British Naval Service embraces many occasions and many circumstances when a vessel of war would be utterly useless unless armed with a shell-gun, but most useful if armed even with a very light gun of that description.

2nd. If these auxiliary vessels, of which the main object is to accompany line-of-battle squadrons, were altogether without anything more powerful than small machine-guns, while they would sometimes be less efficient than they otherwise might be even as squadron auxiliaries, they would certainly be wholly unfit for nearly all the

other diversified services upon which the lighter and smaller unarmoured vessels of the Navy have to be employed. But if armed with a shell-gun, capable of reaching a distant ship, or attacking the shore, they would be available for separate service in peace times, and would take the place, more or less, of the small slow unarmoured vessels just referred to, which are practically almost useless in war time. This would involve an element of economy which should not be treated lightly.

3rd. If these vessels are without a gun, the Admiralty will be under continual temptation in peace time to keep them out of commission, because of their very limited utility during peace; but, on the contrary, if armed with a gun, and therefore fit for more general use, they will offer eligible employment at all times as commands for the younger Officers of the Navy, and will therefore be kept in commission, and furnish the experience which will be so very necessary in time of war.

4th. If these auxiliary vessels, which must be of considerable size and cost, are not made available for more general purposes by being armed with a light naval gun, but are built to act solely against other small craft, by means of the ram, the torpedo, and the small machine-gun only, I feel persuaded that this limitation of their power will operate against their being produced in the numbers desirable.

The above considerations deserve to be duly weighed by naval Officers, and I am disposed to attach great weight to their carefully-formed opinions upon them. My own opinion is that they should at least be supplied with a 6-pounder rapid-firing Nordenfelt gun, or its equivalent. This beautiful little weapon, firing a 2·2-inch shell weighing 6 lbs., with a charge of 2 lbs. 6 oz., penetrates a 3½-inch wrought-iron plate at 1,000 yards, and a 2-inch plate at 3,000 yards. Its weight is but 6 cwt.; its non-recoil carriage weighs the same, and a hundred rounds of ammunition weigh about 10 cwt. 3 lbs. This gun seems almost to have been designed especially to suit the case of these auxiliary torpedo-boat destroyers, for while its destructive effects are such as are above indicated, its rapidity of fire with deliberate aim at 1,000 yards is ten shots per minute. At the same time it seems pretty certain that if armed with a gun, or possibly two, of this description—or with the similar size Hotchkiss naval gun, should that be preferred—these auxiliary vessels would be perfectly available for many of the minor services of the Navy, and so far would naturally displace the slow and much more expensive sloops and gun-vessels, the cost and maintenance of which now form so considerable an item of our annual naval expenditure.

But whether they carry a light naval gun or not, is simply a question of their extended use; for fleet purposes a certain number of these vessels is in any case very necessary to enable our existing fleet to grapple with the torpedo-boats, or other light craft by which foreign armoured squadrons will certainly be assisted, especially in engagements fought—as it is to be hoped our future naval engagements, like most of our past, will be fought—mainly in or near the waters of our enemies, or at any rate away from our own shores. These

vessels will cost about 30,000*l.* to 35,000*l.* each, and the construction of fifteen of them should be one of our most urgent measures. I say fifteen of them, because that would suffice to give one to each of our important ironclads, those built and approaching completion; but if it should be decided to give them a shell-gun each, so as to adapt them for more general service, I am of opinion that at least twenty-five might be built with advantage. In both these figures I am again limiting my suggestions to what I conceive to be the very least possible.

We next come to the question of armoured cruizers; and as this is a subject upon which I have recently written at some length, in "The Times" of October the 20th, and in this month's "Contemporary Review," I shall feel justified in passing over it but lightly here. It would not, I am sure, be satisfactory to the Council if either this paper or this debate were to degenerate into a mere competitive advocacy of rival types of ships; and that is what might be expected to happen were I here to explain in detail the views I take of the extreme unfitness of unarmoured vessels to engage in naval actions, except as auxiliaries to armoured vessels. I will therefore take it for granted that my views on this question are well known and understood. They primarily consist in the belief that where the engines, boilers, and magazines of ships are protected by curved decks, those decks, to be effectual against the fire of even the lightest descriptions of naval guns, must be from $2\frac{1}{2}$ to 3 inches thick; and in the further belief that where the water-line is not protected by armour, it will be liable to be so rent and torn by shot and shell that it will usually be impossible to stop the leakage. In this connection it may not be amiss to mention that even the very small 6-pounder Nordenfelt gun, which I just now adverted to, weighing only 6 cwt., and firing only a 6-lb. shell, penetrates steel plates 1 inch thick when striking them at the very low angle of 15 degrees.

There is one other matter which seems to have a specious advantage in the eyes of some people, in connection with unarmoured ships, but which I feel myself wholly unable to regard as otherwise than as a childish although a dangerous delusion. I refer to the protection which the coal supply of a ship is often supposed to give, and which is sometimes gravely spoken of as a valuable component element of the vessel's defence. Of course I can understand that coal may be so arranged, and ought to be so arranged, as to give whatever protection it can impart while it lasts; let it be well understood that I do not question *that*. But coal is a consumable store, and everyone present knows how fast it is consumed, and knows also that perhaps the greatest of all our naval anxieties is how to keep the ships supplied with it in war time. Knowing this, what are we to think of the foolish pretence that the coal supply of a ship may be reckoned among those defensive powers to which she is to trust? Yet this is continually done, and it is to specious but really silly pretexts of this kind that so many people would fain have us trust now-a-days the lives of our seamen and the honour of our flag. Let us get whatever defence there is to be derived from coal while it lasts, I repeat, but do not let

us play upon the sailor the cruel farce of telling him to look for part of his permanent defence to that which is put on board expressly for him to consume.

Even those who may not be disposed to look upon unarmoured fighting ships with the full amount of distrust which I feel, will gladly assent, I doubt not, to the extreme desirability of our supplying ourselves with a few very fast and moderately armed and fairly armoured vessels, for the protection of our commerce against armed vessels in distant seas. There should be at least one of these for use in the Mediterranean, one for the Atlantic, one for the Eastern Pacific, one for the China and Japan Seas, and one for the Red Sea and Indian Ocean—five in all. How to suggest fewer than these I know not. If fairly armoured and armed, endowed with a speed of 19 to 20 knots, and supplied with abundant fuel, these ships would probably require to be of 8,000 tons displacement. The production of a few ships of this type, and for this purpose, is the next measure which appears to me to be of urgent importance. I feel satisfied that without the power which these very fast armoured cruizers could secure to us, it will not be possible to sufficiently protect our commerce, and keep up our food supplies. The temptations which our mercantile marine will present to enemies and privateers will, in spite of the Treaty of Paris, be so enormous and so widespread, that our unarmoured ships will be set at defiance, unless they are backed up by these fast armoured vessels, which it would be vain for unarmoured ships to engage.

Coming next to unarmoured cruizers, to which we shall no doubt be largely driven by considerations of economy, I would repeat what I have already said about the thickness of protecting deck, which is requisite for the vessels. Two inches of steel would be barely sufficient even if the decks were perfectly horizontal; but these decks never are horizontal in the unarmoured ships, and cannot well be so, because they have to curve up over the boilers, starting from a point 4 or 5 feet below the water at the side and rising up to the water-line, or nearly so, amidships. This is illustrated in Fig. 5, where it will be seen that near the sides of the ship the deck rises up at a considerable angle, and is necessarily exposed to very dangerous blows from shell travelling on the path indicated.

Another point of great importance in this kind of vessel is the depth of the cellular construction and of the cork chambers. Some people seem to forget that the buoyancy up to the load water-line is already mastered by the weight before any injury is sustained, and that whether the water let in by the injury be little or much, any hole whatever will sink the ship unless she is floated by the buoyancy which she acquires as she goes down. You might divide the whole space from the water-line down to the strong deck into a thousand or ten thousand cells, and a single hole would sink your ship all the same, unless you provide floating power above the water-line. This may apppear very trite and commonplace to experts, but it is often entirely forgotten, and ships and schemes of the most helpless and hopeless character are extolled as models of naval construction. But even when these cells are supplied above water as well as below, and

in large numbers, what is to prevent their being opened up fore and aft by raking fire, and athwartship by beam fire, and in all other directions by oblique fire? There is clearly nothing to prevent this, nor is there anything to prevent water following the shell everywhere, when its path is, or becomes, immersed. I do not believe this question of cellular construction exposed to fire has been at all thoroughly considered even by some of those who have advocated it; and I am certain that, unless the subject is thoroughly thought out, many a ship and many a crew will be sent to the bottom in a very summary manner should war arise.

The two absolutely essential points to be secured in unarmoured fighting ships are a sufficiently thick deck over boilers, engines, magazines, &c., and a sufficient reserve of buoyancy under such attacks as may be reasonably looked for from unarmoured but fairly armed vessels. It will cost us some money to give the water-line the safe protection of an armour-belt: it will cost us many lives and many ships if, in some form or other, we do not give the iron or the steel hull some equivalent means of keeping afloat under fire.

Subject to the above, and in view of the total absence of very fast *armoured* cruizers from our Navy, I must admit that there is good reason for adding to the number of our fast unarmoured but fairly protected cruizers.

As to their speed, I think we have not built our recent unarmoured ships fully as fast as they ought to have been. It is now eighteen years ago that the Admiralty, acting upon Sir Spencer Robinson's advice, built ships ("Inconstant" class) of $16\frac{1}{2}$ knots, and we are building none of more than 17 at present. This increase of $\frac{1}{2}$ a knot only in eighteen years is not the progress we are fairly entitled to look for in the Royal Navy, with steel introduced, engines immensely increased in power, and a vast addition to the speed of mercantile ships. I know, of course, that the "Inconstant" had no stout deck; but allowing for this we ought to have made more progress. On the other hand I do not think any one is justified in accusing the Admiralty, as I often see done, of wholly neglecting this subject of fast unarmoured and partly protected vessels, or of failing to give them really high speeds. The appearance of the "Esmeralda," with a speed of 18 knots, has been employed as an illustration of the extreme slackness of the Admiralty in this matter. To my mind it illustrates the very opposite, for if 18 knots be all that a private firm has obtained when making an exceptional effort, and when sacrificing some things that our naval service justly insists upon having in Her Majesty's ships, surely there must be no little credit due to the Admiralty for being able to present to the country a dozen armed ships built and building, some of $16\frac{3}{4}$, some of 17, and some of 18 knots. No good comes of exaggeration and unfairness in these matters, and let us always bear in mind that the Admiralty cannot, for they dare not, sacrifice everything to speed, as is often done in ships of which one hears all about their speed and nothing whatever about their shortcomings. I will, in fairness to all parties, neither say nor insinuate anything against the "Esmeralda" in this respect, for the reason that I never inspected

her after completion. But I have inspected other fast vessels, about which we have occasionally heard favourable outcries as to their speed, and I can say with confidence that they have not been fit for men to live in for twenty-four hours, still less for men to live and work in for years together, to spend the best of their lives on board, and to carry into action against the enemies of their country. There must be many naval Officers present who know quite well that British men-of-war must be made fairly strong, fairly habitable, fairly fit to live, to work, and to fight in; and that no British Government can allow its constructors to sacrifice all or any of these things, and then order Officers and men to occupy such ships without question. And let it be further remembered that every increase of strength, of working or habitable space, of safety, of convenience, of comfort, and of efficiency, involves either a loss of speed or an increase of size and cost.

I cannot myself doubt, however, that in view of our immense naval responsibilities, and of the fact that we are utterly dependent as a nation, even for our very food, upon our protecting our commerce from fast vessels of prey in war time, we ought to be building eight, or possibly ten, ships of 18 knots, of the description just considered, viz., if without armour, yet with efficient deck protection, and a sufficient reserve of buoyancy secured in the best and most trustworthy manner possible. This, therefore, forms the next urgent measure which suggests itself to my mind. Here again I mention a moderate and, as many will consider, an inadequate number of vessels; but I shelter myself under the title of my paper, and suggest only the "most urgent measures" for increasing the Navy.

As the only remaining question, which I propose to speak of, is that of torpedo-boats, it may be well at this point to raise the question how far, in view of the foregoing requirements of the Navy, it may be possible and proper to give up for the future, expenditure upon those slow-steaming, bad-sailing unarmoured ships and other small craft upon which, and upon the repair of which, so much money is now continually expended in the Royal Dockyards, at home and abroad, and elsewhere. I confess that I should very much like to see almost the whole of our expenditure concentrated upon efficient fighting ships. But I cannot forget the multifarious duties of our Navy, nor can I forget that it would be wasteful to employ costly vessels upon some of the lesser of those duties. If we could arm with a gun the fleet auxiliaries, as I have suggested, this difficulty would be greatly relieved, because a single light naval gun, with a supply of machine-guns, would almost always suffice for these minor services. Here again, in the question of the many slow vessels which we now build and keep in commission, we have a matter upon which naval Officers have had great experience, and respecting which they might speak plainly with much public advantage.

Coming now to our last heading, torpedo-boats proper, it appears to me that we require two kinds,—apart from the fleet auxiliaries previously described and advocated. These are the small class carried by the large ships, and a class intermediate between these and

the fleet auxiliaries. Of the former class it has been well said, that it is only under favourable circumstances that they could be lowered and made use of at sea, and this is no doubt correct. But I do not think the Navy would approve of this class of boat being done away with, in view of the very many occasions and services in which they might be employed with great advantage. I am not aware, however, that it is at present necessary to make any large addition to their numbers; the Admiralty have the best information on this point.

Of the larger class, intermediate between these small boats and the fleet auxiliaries, there is now a very useful class of boat of which we are very deficient. I may claim to have had much to do with the introduction of this larger and improved class of boat. Some years ago, when called upon to advise the Government of Japan upon torpedo-boats for its Navy, I pointed out the very limited efficiency of the second-class boat, which is hoisted up at davits, and strongly advised the adoption of boats of at least 100 feet in length and 12 or $12\frac{1}{2}$ feet in breadth, and an order for several was given accordingly to Mr. Yarrow. Since then this type of boat, and still larger types, have come rapidly into vogue. The size and character of these first-class torpedo-boats should be determined by the consideration of their being able to accompany the Channel Fleet on a special expedition, or to be collected at even a Mediterranean port, on an emergency, to join an expedition starting thence. I am aware that boats of 85 to 100 feet in length have been built and called first-class torpedo-boats, and designated a coast-defence type. We must, however, be on our guard against unduly multiplying types, and especially against multiplying types of very restricted capabilities. For my part I see no necessity for more than the two types of torpedo-boat proper, namely, (*a*) that which is carried on the decks of ships, (*b*) that which is about 120 feet long, which steams 19 to 20 knots, carries several days' coal, is armed with machine-guns as well as torpedoes, and affords reasonable accommodation for the crew. These boats could perform all the work of coast defence, or could assemble and accompany a fleet expedition in the manner I have described. They might be produced in quantity for about 12,000*l.* each, and I should think fifty of them could only be regarded as an instalment of what we ought to possess.

The "torpedo-catcher," as I have designated the ironclad's auxiliary, although carrying torpedoes, would also be able to act as a ram against light vessels, and would also, as I hope, carry at least a 6-pr. shell-gun (Nordenfelt or Hotchkiss type), and therefore cannot be classed among torpedo-boats proper.

We have now considered our bare necessities; let us next proceed to count the cost.

The first question that here arises is what portion of the new ships can be undertaken in Her Majesty's Dockyards; and in considering this I may say at once that I see no advantage whatever in building any of the fast auxiliaries, or of the first-class torpedo-boats, in the Royal Dockyards. They should all be built by contract. But the dockyard resources are available for building some of the other ships.

At Chatham Dockyard, on the 31st March next, the "Rodney" is to be $\frac{2}{3}$rds built, the "Warspite" $\frac{9}{10}$ths, and the "Hero" $\frac{1}{4}$th. It is obvious the remaining work upon the "Warspite," and much of that upon the "Rodney," will be fitting work. There is no reason, therefore, why one of the new ironclads should not be laid down there. The design may be ready, and the work laid off by March next. With 88,000*l.* extra for labour, and with materials supplied, she might be $\frac{1}{3}$rd built by March, 1886. Both the "Hero" and the new ships could afterwards be advanced rapidly with the ordinary expenditure of the dockyard. The "Hero" should, without additional expenditure, be advanced in 1885-86 to $\frac{7}{10}$ths.

At Portsmouth, our next great dockyard, the "Colossus" and "Impérieuse" ought both to be out of hand in March next, or soon afterwards, and the work remaining on the "Edinburgh" must be chiefly fitting work. Provision for laying down one new ship this year (a new "Hero") is already made, and a second could be laid down in March next with advantage. To one-third build these two ships, and to complete all the ships now building and completing there, except the "Camperdown," which should be advanced to $\frac{7}{10}$ths, would require about 146,000*l.* extra for labour next year. Afterwards both the new ships could be duly advanced, and the "Camperdown" completed, with the aid of an extra grant for labour of about 75,000*l.* for 1886-87. A fourth of the new ironclad ships might be commenced at Pembroke with advantage, and 50,000*l.* added to the wages of next year, and the same the year afterwards, in pressing her forward, together with the "Howe" and "Anson." The fifth ship should be built by contract.

The five armoured cruizers should also be built by contract, and paid for in equal instalments extending over three years. Two of the unarmoured cruizers can be built in the Royal Dockyards. The "Mersey" will be entirely, and the "Severn" nearly finished next year (1885-86) under existing arrangements; the "Leander," "Arethusa," "Phaeton," and "Calypso" ought all to be out of hand next March, or soon afterwards, setting free a good deal of labour. One of these eight unarmoured cruizers could therefore be laid down at Chatham without delay, and rapidly advanced during the next financial year. The same remark applies in part to Portsmouth, where the "Calliope" is to be nearly completed by 31st March next, leaving the larger part of 20,000*l.* free for the purpose. There is no opportunity of building one of these ships quickly at Pembroke. We have therefore six of these unarmoured cruizers left to be built by contract.

We are now in a position (with the aid of a few calculations which need not be given) to see what extra expenditure is contemplated in the foregoing programme, observing that for approximate purposes it will suffice to deal with actual outlays; also to assume the machinery to cost about 13*l.* per indicated horse-power; the materials of the ironclads to cost about $\frac{1}{4}$th more than the labour; and the materials of the unarmoured ships to cost about $\frac{2}{3}$rds of what the labour costs. We shall now have—

Proposed Additional Expenditure.

	Extra expenditure in 1885-86.	Extra expenditure in 1886-87.	Extra expenditure after 1886-87.
	£	£	£
For hastening armoured ships now building in Royal Dockyards, and pushing forward there four new armoured ships of the first class, labour, materials, and machinery (by contract) included	750,000	275,000	Nil.
For building by contract one additional armoured line-of-battle ship (about 700,000*l.*) and five armoured cruizers of 19 to 20 knots' speed (at, say, 500,000*l.* each).....	1,000,000	1,100,000	1,100,000
For building by contract six fast unarmoured cruizers of over 18 knots' speed (in addition to the two to be built in Royal Dockyards), in two years, at 175,000*l.* each	525,000	525,000	
For building by contract fifteen extremely fast vessels to accompany ironclads as auxiliaries, at, say, 32,000*l.* each	480,000		
For building by contract fifty first-class torpedo-boats, at, say, 12,000*l.* each	600,000		
	3,355,000	1,900,000	1,100,000
	1,900,000		
	1,100,000		
Total extra expenditure in next three years	£6,355,000		

Under the above programme we should get:—

5 additional armoured ships of the first class.
5 extremely fast armoured cruizers.
8 extremely fast unarmoured cruizers.
15 extremely fast auxiliaries to armoured ships.
50 torpedo-boats of the first class.

There are those who will consider the above programme extravagant; I would ask them to remember that the state of things at the present moment is this. In modern ships with thick armour and heavy guns, built and building, the French are outstripping us by armoured tonnage equivalent to seven and a half fully armoured ironclad ships of the very first class. I have only proposed to proceed immediately with five out of the seven and a half, of which we are deficient as compared with France alone. As to the armoured cruizers, we are at present without a single ship of the speed of, say, 18 knots, which is proof even to Mr. Nordenfelt's 6-cwt. gun firing $2\frac{1}{4}$ lbs. shell. Is

there any man in his senses who would deny that five is the least number of ships protected by armour at the water-line that this country ought to possess for the security of its commerce all over the world? Of very fast unarmoured ships to assist in securing that commerce, I have proposed to build but eight—surely a very small number indeed. Of the auxiliary ships, fifteen—about one for each of the most important of our armoured ships: can any one doubt that this is a most moderate, almost a feeble, suggestion? As to the fifty first-class torpedo-boats, I believe there is no one, whose opinion is worth anything at all, who will venture to doubt their urgent necessity. On the other hand, to those who consider the above programme meagre and inadequate—and among these I fear I may have to reckon my noble friend Lord Henry Lennox, who has taken very much more than a merely political interest in this great question, and brought great ability to bear upon it—I would say that its adoption would put us in a position so far superior to our present one that I am content to suggest it, conscious as I am that the difficulty of getting it adopted will be in direct proportion to the magnitude of our proposals. I fully admit, however, that it must be succeeded by further earnest effort.

Finally, whatever may be thought of this programme, it should be borne in mind that every portion of it would tell upon the strength of the Navy, and the safety of the country for a long time to come. The extra expenditure which it necessitates is but little more than one-half the ordinary Navy expenditure for a single year, and whereas all save a million or so of the annual eleven millions totally disappears in wages, clothing, provisions, pay, pensions, &c., at the end of the year, the results of this extra outlay would remain with us, and would greatly tend to restore to the country that sense of security, and to foreign nations that proper regard for us, which there is reason to fear are at present greatly wanting.

The CHAIRMAN: Before proceeding with the discussion upon this very important paper, I wish to mention that I have received from Admiral of the Fleet Sir Thomas Symonds a short memorandum which contains the substance of what he proposed to say upon this paper had he not been prevented from attending by illness and other causes. It is not the custom in this Institution to read papers from those who are not able to attend the discussions, but considering the high authority of Sir Thomas Symonds, who is one of the ablest and most experienced Officers in the Navy, and the very great attention and care that he has bestowed upon this subject, I think it would be the wish of this meeting that what he has to say upon the subject should be read. Admiral Symonds writes as follows: "Having been invited by the President and Council of the Royal United Service Institution to attend the lecture on Wednesday, and (as it is on a matter of the greatest possible importance) being prevented attendance by gout and other reasons over which I have no control, I venture to request that what follows may be read for me as I am prevented speaking it. The plans presented by Sir E. Reed speak for themselves, showing the enormous surface above and below the water-line of the 'Collingwood,' which is unarmoured for about 200 feet of the water-line, whereas 'Duperré' has thick armour, fore 16 inches and aft 14 inches (Sir T. Brassey, vol. 1, p. 316, *idem*, p. 311), and a depth of 8 feet 1 inch, being 2 feet 6 inches above the water-line, and 5 feet 7 inches below it, or 200 × 8 feet 1 inch = 1,612 superficial feet (about). These unarmoured ends of our ships, in presence of the thickly armoured ends of the French ships, seem to me the outcome of so awfully risky and

mad an experiment that I cannot too strongly urge its being remedied by armour the whole length; and, to prevent loss of time, in vain argument, that the matter be experimented upon by actually firing at the unarmoured ends of the 'Collingwood.' Again, see the unarmoured ram of the 'Collingwood' against the ram of 'Duperré.' Imagine it struck by a heavy shot when exposed scending and pitching. It would be disabled, and that greatest of all weapons, the ram, made useless, while 'Duperré's' armour would glance the shot off. It appears to me that there is a certainty of our ship losing the battle against 'Duperré' before it began. In arguing this point, Sir E. Reed omits to state that the French ships have, equally with our own, armoured decks and the cellular system, besides armour throughout the water-line above and below for 8 feet 1 inch. In the comparison of the armoured ships with armour 15 inches thick, I think it very unwise to omit 'Brennus' and 'Charles Martel;' it is like over-rating one's strength. They are in 'Carnet' and French estimates 1884 and 1885, with large sums voted, 158,000*l*. In comparing the 9-inch armour ships, he omits French 'Tonnant,' $17\frac{3}{4}$ inch, 'Friedland,' $7\frac{7}{8} + 1\frac{1}{2}$ inches = 9 inches, 'Colbert,' $8\frac{3}{4}$ inch, 'Trident,' $8\frac{3}{4}$ inch, the two first being 9 inches and over, and the others nearer 9 than 8. How very wise to under-rate: but 'Tonnant' and 'Friedland' are omissions. From our list I should omit the five cruizers, which I was told on authority, when they originated, were not in any way intended for battle, and are neither one thing nor the other. Sir E. Reed's additions seem to me most moderate. I should armour the ends of all our armour-clads built since 1873 now unarmoured, and build with all expedition a navy double the French, using their models for our guidance in all classes of war vessels. If they have one A, I should have two A's, and viewing the incalculable duties of our Navy and the use of steam *that* would even be insufficient. But without a double force, as in the days of our wise forefathers up to 1858, a naval Sedan is certain in case of war with France alone. How coal and repair accidents in the face of an equal force (as at present) when the French need only go to sea from choice, whereas we must keep the sea, keep our enemy in port if possible, and if he comes out, give a good account of him? I should have armoured cruizers to convoy the trade, attended by 'Servia's' to coal, tow, and attend them in all ways. No unarmoured vessel is really fit to fight. On all other points I quite agree with Sir E. Reed's most excellent paper, for which I am most truly grateful."

Admiral Sir GEORGE ELLIOT: It is a very serious task which an Officer undertakes in attempting in a short space of time to answer this most able lecture. Knowing that many Officers would wish to address the meeting, I have endeavoured to condense my remarks as much as possible. In the first place I feel certain that as a valuable supplement to the mass of opinions which have already been published through the press, the Service will feel greatly indebted to Sir Edward Reed for coming forward at the present time to support the wants of the Navy. This lecture is most comprehensive and practical, and has the merit of introducing constructive features of great value on some most important points. I would notice in the first place that Sir Edward Reed's urgent demands refer solely to the ocean fleet, whereas the flotilla for coast defence is an important feature of the Navy proper, inasmuch as the Admiralty has to provide the flotilla, and the stronger those defences are *per se* the greater will be the freedom and offensive power of the sea-going fleet. Therefore I consider that heavily armed gunboats for coast defence, of which we have none worthy the name, are an urgent necessity, and on that point the lecturer has expressed no opinion. There are, however, a few points in the lecture on which I desire to offer one or two remarks. First, with regard to shortening the length of time occupied in building and completing our ships; this is a point which cannot be refuted, but I suppose it is connected with the question of finance, and if we could only get rid of this rivalry between political parties over the Naval Estimates, probably we should find ships built more quickly than heretofore. Then as to the question of central citadel ships and unarmoured ends, Sir Edward Reed's remarks on the subject must be considered under two heads, one being unarmoured ends and central citadel *versus* an all-round belt of stout armour, and the other being thin armour-belt *versus* deck armour and cellular water-line or raft body. I think that as between a thin armour-belt and a cellular water-line with submerged armour deck, so long as you secure surplus buoyancy, it

will not be said that there is any objection to that. The central citadel and unarmoured ends were a necessary accompaniment of revolving turrets with armour above 12 inches thick, and a displacement under 10,000 tons. I strongly condemned this feature of design in 1871, as a member of the Committee on Designs for Ships-of-War, as will be seen by my dissentient report, and recommended barbette towers fore and aft, protected water-line, and fortified bow and stern. Now the barbette towers have been adopted I presume we shall hear no more of central citadels and unarmoured ends, but in perpetuating this evil since 1871, the Admiralty have only followed the recommendations of the majority of the Committee. I am still of opinion that with a submerged covered deck with 4 or 5 inches of steel plating, and with a raft body and coffer-dam sides, a better protection will be afforded to the vitals of the ship, her ammunition, her boilers and engines, against a gun attack than that offered by a belt of less than 12 inches of armour. However, to discuss this feature of protection adequately would require a lengthened argument, and I shall merely point out that one shell from the guns now mounted penetrating a thin armour-belt may reach the boilers and magazine, or flood the engine-room, whereas no gun will penetrate a stout horizontal deck, and a raft body will stand a good deal of riddling without fatal consequences. I wish to point out with regard to the raft body that these cells are always described as going not only from the water-line down to the deck, but also from the water-line upwards 5 or 6 feet to secure buoyancy, and I would prefer that mode of protection to a thin belt of, I won't say 12, but 9 or 10 inches. At the same time with regard to our armour-clads, unquestionably what Sir Edward Reed has said about the danger of our unarmoured ends is one of the most prominent features of the defective condition of our Navy. The unsoundness of Sir Thomas Brassey's mode of comparing the strength of navies has been so fully exposed by the lecturer, that it needs no comment on my part. One of the features of the lecture that has pleased me most has been to find that an authority like Sir Edward Reed has expressed an opinion that it is possible to defend ships against torpedoes. I do not say whether his plan is the best, or whether the plan that I introduced is the best; both plans require to be tested by exhaustive experiment; but I have endeavoured to find out from torpedo experts what the effect would be on a torpedo bursting against a ship with a fixed crinoline protection 6 feet from the ship, and I have been told that a water cushion is the most effective plan of resisting a torpedo. No doubt if a torpedo can be resisted by the mode which Sir Edward Reed has brought before us, it has the immense advantage that the ship does not lose speed, whereas with a crinoline according to Mr. Froude's calculation, at any rate only one-fifth of the speed would be lost by friction. I am therefore glad to hear from such an authority that he deems it possible, because if he can protect ships against torpedoes it solves one of the great problems of the future. I believe it can be done, and if it comes to our having to place a fixed crinoline and to lose a certain amount of speed only for vessels intended to fight in line of battle, not for vessels cruizing alone, where they can manœuvre and destroy the torpedo-boats, but where they are compelled to keep together in a confined space, and cannot fight the torpedo-boats,—I say I would rather go with a loss of speed into an action of that kind with a fixed crinoline protection securing my ship, than have the speed which I do not think would be very available in a fleet action. The supreme importance of this feature of design calls for the earliest possible solution by experimental test, without which no accurate opinion can be arrived at. I proposed in 1876 to the Admiralty a plan, Sir Edward Reed has now proposed another. It would take too long to discuss this matter on this occasion, but it is manifest that it should be at once reported upon by a Select Committee. Sir Edward Reed has not informed us what the tonnage of these auxiliary vessels which he mentions would be.

Sir E. J. Reed: I really have not looked at the question in that form.

Admiral Sir G. Elliot: At any rate there is no doubt that the prevailing opinion has been that to resist torpedoes, we must have what Sir Edward Reed calls "torpedo-destroyers"—vessels something of that class. This is a very large question. I quite agree with the spirit of this recommendation. I have always strongly condemned the folly of building small craft of slight speed, solely for peace services, of which class we have some 200 on the Navy List, but the exact character of the substitute for this class and the war purposes for which they should be

designed requires grave consideration, whether they should be armed cruizers for the protection of commerce or auxiliaries for ships, is a question upon which I should rather be inclined to differ from the lecturer, more especially if line-of-battle ships can be afforded torpedo protection in some such mode as the lecturer has proposed. To arrest the torpedo-boats by torpedo-catchers would not be so easy as might appear. A vessel going 20 knots firing a gun on an unstable platform does not often hit its mark, and some of these torpedo-boats, notwithstanding your torpedo-catchers, if they were making a rush at the enemy's fleet in advance, would unquestionably pass through uninjured. Therefore I do not think the torpedo-catcher would be a secure protection. They might catch a few of them, but if we can protect the ship itself it is far better, and then I think that instead of our small craft something more in the character of the armed cruizer would be much more likely to fulfil those conditions which Sir Edward has so ably described, of comfort to the men, than those small vessels called torpedo-catchers; and then there is another thing: in the struggle between torpedo-boats and their catchers, numbers would tell; but that is another problem which I consider should be thrashed out by a Select Committee. As to the question of armoured vessels for the protection of our commerce, Sir Edward Reed points to "Impérieuse" class, and states that to attain a 20-knot speed would require a tonnage of 8,000, and he proposes to have six of those vessels. I call them second-class armour-clads for the protection of commerce; I think they would be a most desirable class of vessels, in fact, necessary to meet similar vessels which are being built by foreign Powers. Now coming to unarmoured cruizers, I quite agree that a deck of 1-inch steel is no protection; instead of 2 inches I should say 3, and vessels of that type with fore and aft decks, covering their vitals with 3 inches of steel, would, I think, considering that you could build three or four of them for one "Impérieuse," and seeing that numbers would tell, be most desirable. With regard to the speed of our vessels, I agree with every word the lecturer has uttered, and also with regard to torpedo-boats. Now I come to the last point, *viz.*, the proposed additional expenditure. I am glad to find a gentleman who has been so long in office, and who is therefore to a certain extent tarred with the official brush, so generously disposed as Sir Edward Reed has been, but for my part I should double every item that he has named. He has given us this merely as an instalment, I would double it as an instalment, and as a first instalment, and I would merely say that in my opinion it is most urgent that the programme of expenditure proposed should at least be doubled as regards each item referred to on the list. This is an absolute necessity if we are to guard the Channel and the Mediterranean, and protect our Colonies, and trade routes, without which our Empire cannot be defended in the event of war with France alone, to say nothing of France and Russia combined.

Admiral Sir J. D. Hay, M.P.: I will endeavour to compress my remarks within the ten minutes which I believe we are entitled to, and therefore I shall say, as briefly as may be, what I wish to say upon this lecture, thanking Sir Edward Reed for it, and agreeing with it most completely as far as it goes, but not being satisfied that it goes nearly far enough; and I trust I may be permitted to give a few reasons why I think it had better go at once a little further. I believe the remarks which I shall make are within the order of reference—"What are the most urgent measures that should be taken for increasing Her Majesty's Navy?" The first and most urgent measure to be taken is to get some money, and I am glad to see some colleagues of mine in the House of Commons here, notably an ex-First Lord of the Admiralty (Mr. W. H. Smith, M.P.), who I am sure will assist in that desirable consummation, and my noble friend (Lord Henry Lennox) who has for so long a time been urging upon the attention of the public the terrible condition of the country and its defencelessness. The expenditure upon the coaling stations is not a naval question; we have nothing on earth to do with that. The ships are of no use without coal, but it is not the Admiralty's business to fortify our coaling stations. In fact, some years ago we and a good many other naval Officers were of opinion that if the 14 millions expended upon fixed fortifications had been expended on the Fleet, the country would have been in a more defensible condition. The fortifications at Portsmouth would not prevent a smart French Officer burning Liverpool or bombarding Brighton, and these are things which might happen to us

to-morrow morning if the French pleased to do it. I think it will not be irrelevant if I say that I do not believe myself we have any right to be jealous of France for increasing her Fleet. It is the business of France to increase her Fleet, and I daresay my friends who have read that most interesting book, Lord Malmesbury's Memoirs, will remember how he relates that having been Foreign Minister and being in Paris, the Emperor was much out of humour that Lord Palmerston's Government suspected all he did, and always complained of his building ships, and after ridiculing it as being childish, said: "Let each build what he considers the right number. You ought to have twice as many as I, as they are your principal protection." Now that is my view. At this present moment France has a right to increase her Fleet very largely. There has been a combination between Germany and Italy before now; not as against France, but against Austria; and at the present moment the German and Italian armour-clad Fleets combined, which were never considered before as existing at all, show a total of 37 ironclads. If I am not mistaken at this present moment, we may perhaps say France has something like 45 available sea-going armour-clad ships of various kinds, Germany has 12 and one building, and Italy has 14 and 9 building, making 36 in all; so that the French, deducting the 11 obsolete ships from their 56, without going into the question of the armour-clad water-line, have only 45 as against the combined Italian and German Fleets. I believe we have only 39 to the French 45 when the French ships are all built. At any rate we have no right to be jealous of France for increasing her Navy, which is not increased beyond what she requires as the second great maritime war-power in the world, omitting America; but if the Navy of France is not quite so large as it requires to be, ours unfortunately is only half the size that it ought to be, and therefore the number of ships which is suggested by Sir Edward Reed is to my mind entirely insufficient. If I had had time I would have gone over the ships of the French and English Navies, but I will not do so. I should like to say with regard to the class of ships which I think it is right should be built, it is quite true the "Amiral Duperré" is a much more formidable ship than a ship which is not armoured round the water-line, but if you can get a completely armoured ship that can keep the sea and have the speed of the "Duperré" for less money and with a sufficient amount of armour and gun-carrying capacity, I would rather have two of those than one "Duperré." I venture to say that, because I have elsewhere alluded to a ship, the "Riachuelo," of 6,200 tons displacement and a greater speed than the "Amiral Duperré," completely armoured by a belt, not in my opinion carrying heavy guns enough, but carrying four small guns instead of two big ones,—I would prefer that to one "Duperré," and I believe that five of those would defeat three "Duperré's." I would rather have a greater number of the smaller ship if she is fast, can keep the sea, and has all the other advantages than go to the very great size which is spoken of with reference to the "Duperré." But that being so, I am not satisfied that the number of ships proposed by Sir Edward Reed is at all sufficient for the purpose. I think that we must do all that the country can do with its present resources to recover ourselves from our naval inferiority; and what I would venture to propose would be, that in addition to the ships Sir Edward Reed has suggested, and not touching upon any other portion of his estimate but the armour-clads, that every slip in the country—and there are twelve unoccupied upon which an armour-clad ship could be built—should be at once occupied by such a ship. The cost of these, assuming that they would take three years to build, would be 7,200,000*l.* Adding this to the 5,330,000*l.* proposed by Sir Edward Reed, would give a sum of 12,530,000*l.* to be distributed over the next three years, or 4,172,000*l.* in each year. Now our Navy Estimates are 9,000,000*l.*, and with the addition of 4,172,000*l.*, they would only be 13,000,000*l.*—13,000,000*l.* for the Navy is really nothing. Sir Spencer Robinson can confirm me when I say that in the year 1861—a peace year—the Duke of Somerset, with Mr. Gladstone as Chancellor of the Exchequer—had 12,500,000*l.*, because the French were building armour-clads and completing screw line-of-battle ships. In 1862 they had the same sum, 12,500,000*l.*, and Mr. Corry, First Lord of the Admiralty, stated in the House of Commons that less than that sum annually could not keep the Fleet efficient. Another First Lord of the Admiralty, whom I see present, in 1878 had 12,400,000*l.*, the only other occasion on which it has been spent, but he was obliged

to spend it in going to an old clothes shop and buying second-hand ships instead of building the ships that were wanted for the Navy. In a sudden fit of indignation my right hon. friend purchased three Turkish ships and a Brazilian ship, and added them to the Navy, and in good time, too, for without them we should not have had ships enough to carry on the ordinary peace duties of the Fleet. I therefore suggest that 13,000,000*l.* should be spent upon the Navy, not only for the next three years, but for ever, until war is not required. Including the Indian army and the armed forces of the Colonies, all round we spend 32,000,000*l.* a year, and we grudge the Navy 8,000,000*l.* for its efficiency, and 8,000,000*l.* is all that is spent upon the effective force of the Navy. At the time I speak of 11,000,000*l.* were being spent upon the effective naval force at a time when everything was much less costly than it is now, and the necessities of the world required far less preparation. For these reasons I urge upon the meeting, if they can mend Sir Edward Reed's most excellent paper, to mend it in the sense of adding to the Navy Estimates a sum of 4,000,000*l.* a year. There is one other point which might be touched upon, and I hope some other speaker will do so: it is the great want of guns for the Navy. At the present moment we require for armour-clads in existence 587 guns, and for other vessels 1,658 guns, and for the merchant ships which are said to be ready to receive guns in war time we require 560 guns; so that we require for the Navy 2,805 guns, and as a reserve of 800 guns has always been considered necessary, that would be 3,605 guns, and we have 387 complete.

Admiral Sir SPENCER ROBINSON: I certainly cannot do less than congratulate the Council on the very excellent, praiseworthy, and courageous step they have taken in calling upon so able and so well-informed an authority as my friend Sir Edward Reed to give a lecture on this important subject. I rejoice that the Council has taken this most praiseworthy step. I rejoice because it has proved to demonstration that it is the opinion of this Council that the state of the Navy is inadequate for the wants of the country, a state of things which I have urged both publicly and privately on every Admiralty in this country. I rejoice I say that this Council has taken this step, and I consider that it has thereby demonstrated the proposition that I have just enunciated. What I regret and what the constitutional organization of this Institution precludes me from doing is, that I cannot propose, if the lecture is agreed to, as it will be agreed to, unanimously by the audience which has been collected to hear it, that this Institution should pass a resolution carrying the weight of their opinion before the Admiralty officials, and in the shape of a petition, or in any other way that might be laid before the House of Commons. For I cannot but see that isolated efforts such as those made by my noble friend Lord Henry Lennox, made by the worthy Admiral who has just spoken, an old friend and colleague of mine, made by that excellent and experienced officer, Admiral Symonds, made by the lecturer himself in and out of Parliament in various ways, I cannot but perceive that all the isolated efforts of remonstrance and exposition that have been made have failed in producing the effect they were entitled to produce because they were isolated, because they did not come with the united voice of the Army and Navy who could then come before the country and say, "It is we who shall suffer in life, in reputation, in carrying out the plans that those in authority have commanded us to carry out; we shall sacrifice all these things, and we know that the chances of success will be small indeed." It is in that light that I regret that the organization of this Institution will not permit us to do anything of the kind. What I wish to say to every naval Officer who hears me, to all these highly-educated Engineers and Officers who, with myself, have long looked upon the defences of the country in what people are pleased to call an "alarmist" spirit, or even in a "fanatical" spirit—I do not care what people say, for in that point of view I believe that our military and naval defences have long been insufficient for the wants of the country—what I wish to say is, that the isolation of our attempts to remedy this has been one cause that it has not been remedied. And still further than that, the immense diversity of the opinions of naval Officers (I speak of that specially because I know it well) on every possible subject is now, and has been for years, operating against any step whatever being taken for the amelioration of the condition of our Navy. I could go to a drawer to-morrow in the Admiralty and pull out 20 fathoms of objections to every single thing that ever happens to be

proposed and ever will be proposed, and I ask in that state of circumstances what any set of men who have the responsibility of deciding upon these various questions are likely to do; I do not say what they ought to do, but what are they likely to do? They are likely to say, "Why, this experiment, this design we are called upon to embody in a ship-of-war, is opposed, here are a whole lot of letters saying it is useless." They turn to the other side and find every possible objection from perfectly different points of view put before them. Now what I wish to do is to utter a few words of warning and advice to naval Officers. We have now arrived at a crisis: we have the opinion of the country with us—I believe I may say so without any doubt—that the Navy is inadequate to the wants of the country. Instead, therefore, of applying our ingenuity and applying the education we have derived from the writings of persons well versed in naval architecture and in designing ships, and from the excellent and most useful proceedings of this Council in getting lecturers to give us all the information that they have acquired, and the still more valuable method of giving prize essays and rewarding the best essayist, whereby a knowledge of these subjects has been disseminated in the Navy, and naval Officers now stand in a very different position indeed as to knowledge and judgment on these matters to what they did fifteen years ago; instead, I say, of applying all this knowledge to the airing of individual crotchets, having once obtained the unanimous consent of the country that the Navy is inadequate, do not dissipate that by anything like hypercriticism. I was going to say I never yet knew a perfect woman, but I never knew a perfect ship, and never shall. Therefore I say stick to one point, stick to this, that the state of the Navy is insufficient. You have a scheme before you; I need not say in every word of that scheme I must cordially concur. I think it is one of the most remarkable expositions of what a war navy should be that I have ever heard put before this Institution, and I hope that you will so support it by your unanimous consent that it will command universal attention.

Lord HENRY LENNOX: Sir Edward Fanshawe and Gentlemen: I feel very great reluctance, as a purely unprofessional man taking a strong interest in naval matters, at intruding myself before an audience composed, as this is, of naval Officers, engineers, and other professional gentlemen, who have had advantages such as have been denied to me. The only comfort that I have is that we are restricted to ten minutes. Ten minutes is a very short time, but my First Lord of the Admiralty, when I was Secretary—the late Sir John Pakington—told the country that in ten minutes he had settled a Reform Bill for the nation; and, therefore, it is quite clear, that if Sir John Pakington could make a new Constitution for the country in ten minutes, I shall have plenty of time within that limit to express my entire approval of Sir Edward Reed's lecture. I look rather old to be a pupil of anyone who is living, but, as far as naval architecture and naval subjects go, I am the humble pupil of Sir Spencer Robinson and of Sir Edward Reed. I entirely agree with Sir Edward Reed's paper; and without wishing to be egotistical, I say so, because in the main it carries out those sentiments, those objects, and those wishes that I have tried in and out of Parliament, now for some twelve or thirteen years, to impress upon the attention of my fellow countrymen. I am most gratified to think that on Monday or Tuesday next we shall have a public recognition on the part of the Government of the fact that the Navy, as it is now, and as it has been allowed to dwindle into the last few years, is not sufficient to protect our commerce or our Colonies. I will run very hastily over some of the points which I have noted. First and foremost I entirely agree with Sir Edward Reed, and I think no one will differ after hearing his calm and patient analysis from the opinion that the great need of the moment is a considerable addition to our Navy, and that if we do not make that addition we shall very soon find ourselves not even equal, but astern of another navy of which I wish to speak with all respect, and which I will not characterize. There is another point on which I entirely agree with my hon. friend and with Sir Spencer Robinson, viz., the mischief of the delay in the production of our ships. The delay in the production of those ships means two things—it means, first of all, increased cost, and secondly, diminished efficiency in the ships when they are produced. When they are ready for commission they are no longer ships of the newest type, having been kept in our dockyards for so many years. I am not now going

on to refer to the "Inflexible," which is an old story, and which furnished the most peculiar example of a ship; but I may state with regard to the "Agamemnon" that I moved for a Return to know how many years it was computed that she would take in building, and that Return, although Sir Thomas Brassey was good enough to say that he would send it to me before now, has never reached me. From outside sources, however, I learn that this ship, which has gone out to defend the honour of our flag in China, and which is armed with only 38-ton muzzle-loading guns, and which has a strange way of careering about in the waters when she is called upon to go the way they want her to go, I am told that this very ship took nine years before she was ready for commission, instead of four years, the computed time. Now, gentlemen, the great fault of this is that the Government of the day—I do not care what Government it is, whether it is the Government of the present day or the Government of my right hon. friend (Mr. W. H. Smith) or the Government of Mr. Goschen—I say that none of them have the courage to ask for the number of dockyard men that they know are necessary to carry out the programme that they present to the House of Commons. I have taken some pains to go through this, and I find that, as a rule, the number of men they have asked for in the last few years was barely sufficient to undertake and carry out one of the two items into which dockyard work is classed, viz., repairs and refits, or construction. The result of this is that the men are taken off construction and put on to repairs, or else they are taken off repairs and put on to construction, in order to shove forward an extra ship a few degrees further, so as to make a show in the Naval Estimates of the following year. Now I have a very high authority for pointing this out, and that is the former Secretary of the Admiralty, Mr. Trevelyan, who said in his speech in the House of Commons that they could not have advanced their armour-clads at all if it had not been for the great exertions of their predecessors in office in repairing ships, and he says this, which I hope you will all note, that so great was the necessity at that time, so crying was the evil, that in one year my right hon. friend had, with the exception of one ship, to devote the whole force of Chatham Dockyard to repairs and refits, and no construction at all. That is a state of things which we must all deplore, as being utterly wrong and as being calculated to increase the great evil in building and bringing forward of the ships for commission. There are other matters which I should have dwelt upon, but being anxious to carry out the ten minutes doctrine, and having the opportunity on Monday or Tuesday next of the hope of speaking fully and at some length on this subject, I will not trouble you with many other observations now. There is one point referred to by Sir Edward Reed as to the way in which they calculate tons weight of the hull, in order to tell the country how much of a ship has been built, but really I do not wish to go into that, because my friend Mr. Campbell-Bannerman, who has now gone from the Admiralty to that bed of roses in Ireland, told us that a ton is not a ton, and he would be a very clever man who told us what a ton was. I therefore pass that by; my noble and gallant friend Sir John Hay has dwelt upon the amount of tons, but I am not going to enter into that this afternoon. I am only going to ask you all to observe that one of the most peace-loving, one of the most unfighting men, except with his tongue and his pen, in the House of Commons, Mr. Broadhurst, yesterday in Yorkshire declared his willingness to vote anything that Mr. Caine, the newly-appointed Lord of the Admiralty, wished, in order to have a Navy that should protect our floating wealth all over the world. I hope we need not have any alarm as to getting proper funds at the proper time. I am not going to make any proposal now, neither am I going to touch upon the question of guns to-day. I shall touch upon guns for a very long time on Monday or Tuesday. I am not going to touch upon torpedoes, it would be touching upon that which does not exist, but there is one thing I am going to touch upon, and only one, and that is that now, by dint of hammer and tongs, of speaking and writing and pressing on the country the palpable wants of our Navy—now that the Government have taken it in hand, and on Monday are going to make a statement through their mouthpiece, Sir Thomas Brassey, my hope is this, that the proposals of the Government will be adequate, in which case they will receive the same constant energetic support from me, as if I were one of those Government hacks whom we occasionally hear spoken of in the newspapers. I am afraid, however, that it is hoping

against hope. All I have to tell you to-night is that if on Monday next the Admiralty offer to us who are clamouring for bread nothing but a stone, they shall receive my most consistent opposition, both in and out of Parliament, until they have done justice to the country and have given us a Navy worthy to carry our flag all over the globe.

Admiral VESEY HAMILTON: I most heartily agree in nearly everything that Sir Edward Reed has said, and will simply adduce statistics in order to prove his main point, namely, our great want of armoured ships. In 1793 we had 113 serviceable line-of-battle ships, and the French had 80, and we had 133 frigates, while the French had 77. During the next eight years we gained a series of great victories, and in 1801 we had reduced the French Fleet to 39 line-of-battle ships and 38 frigates, but had increased our own force to 202 line-of-battle ships and 277 frigates. And we had at that time actually in commission 104 line-of-battle ships and 126 frigates, or 2·7 ships of the line against one of the French of all sorts, and 3·6 frigates in commission against one of the French, showing the immense interests we had to protect then, and the efforts we made to do so. Now the most that is claimed for us at the present moment is that we are on an equality with the French. I am sure every one will agree that our naval superiority should be unquestioned, as it was in 1863, when we had 21 ironclads and 44 screw line-of-battle ships as against 16 French ironclads and 29 line-of-battle ships. In those days our superiority was unquestionable. The lecturer justly fears the effects on the French with a combination if they find themselves on a par with us as regards naval force. I must agree with him on that point. I am told that the late Emperor of the French once said to one of our statesmen, "If you do not keep up a strong navy, I cannot guarantee peace." We all remember the demands of the French Colonels on the Orsini bomb business. The answer to those threats was the Volunteer movement, and we know from the American Civil War what can be done by a civilian army. I will now read you what Admiral Aube, a distinguished French naval Officer, says in the "Revue des Deux Mondes" of March 15th, 1882:—"The empire of the sea will belong to that nation of the two which has the most numerous armoured fleet." "Every power of attack and destruction will be employed against all England's littoral towns—fortified or unfortified—whether purely peace establishments or warlike—to burn them, to destroy them, or to pitilessly ransack them." "In any future war the French will come down from the heights of that cloudy sentimentality which has created the monstrous association of words—rights of war (*les droits de la guerre*), and the attack on every source of riches will become not only legitimate but obligatory upon them." I see around me some ladies who, I have no doubt, have come back from Scarborough. They know what they have to anticipate if the French gain the upper hand. I trust we shall have in addition to our naval force a Naval Reserve, but I am perfectly certain of one thing, namely, that if the fortune of war places the French littoral towns at our disposal, that no naval Officer would follow out the statements put before us here by a French Officer. There is another point to which the lecturer has spoken, and that is that unarmoured ships are not fit to take their place in line of battle with armoured ships except as auxiliaries. The American Civil War again shows the correctness of his conclusion. The "Tennessee," a very poor ironclad, was attacked by six corvettes and three monitors at Mobile. The "Tennessee" could not sail more than 5 knots, but yet it took those nine vessels an hour and three-quarters to make her surrender, and that was only accomplished after her steering gear was disabled, her funnel shot away, six men wounded, and three killed. Her crew were half suffocated by the smoke, half stunned by the ramming of the wooden ships, and blinded by the blast of burning shell. Only one shot penetrated this extemporized ironclad, and had her speed been 10 knots I think the result would have been very different. As it was, she inflicted a loss on the Federals of about 30 killed and 100 wounded. The "Albemarle," an ironclad ram with two guns, was attacked by eight gunboats, all specially told off for the affair. After an engagement of three hours, with her two guns against this large number, she withdrew when darkness came on, not having lost a single man, while the loss of the Federals was many men killed, wounded, and scalded. Another ram—and these rams were not what we should call ironclads at the present day—the "Arkansas,"

with six guns as against ninety guns of the Federals, ran past Farragut and Davis's fleets, and inflicted a loss of eighteen killed and sixty wounded, she herself only sustaining the loss of five killed and six wounded. No wooden vessel would have dared to have run the gauntlet. There is a point on which I think very strongly, namely, the necessity of protecting our commerce. We have lately heard a good deal about the transfer of our commerce to neutral flags. I think the statement is one that will bring ruin and disaster to England if it is carried out. During the French War of 1803–14, the number of British ships increased from nearly 5,000 to nearly 9,000, and the tonnage from 922,594 to 1,372,108. In the same period foreign shipping diminished from 5,497 to 5,314, and its tonnage from 780,115 to 746,958. The historian, Alison, says it was "because the Navy of England gave that protection to its commerce without which it could not have been carried on." The transference of our commercial flag in war time to neutral nations appears to be seriously contemplated by our rulers and merchants; it is to me a new and most startling doctrine. I have heard it said in this assembly that our commerce is a source of weakness to us. I say no, it is the greatest source of strength that we have. It is from our commerce that we get the sinews of war. Readers of Motley know it was the wealth obtained from the sea that enabled the Dutch to equip the armies that eventually overcame the greatest Generals and finest troops of the age, notwithstanding their possession of the silver mines of Mexico and Peru. In my opinion, whenever the Navy fails to protect our commerce, the Navy fails in its mission, and I for one should feel ashamed of belonging to it.

Captain G. Noel, R.N.: The whole meeting will, I am sure, most cordially thank the lecturer for his very powerful lecture. On the general question I object to the principle of sudden and irregular votes of money for the Army or Navy. They are apt to lead to extravagance and waste. For the last fourteen years the Navy has been starved; we ought to have had at least one million of money yearly added to the Navy Estimates. In this I am sure all naval Officers will agree, and especially the Naval Lords of the Admiralty. The consequence is that we are terribly behindhand. It may not sound well from naval Officers to speak on this subject; they lay themselves open to the accusation of magnifying their own office; but I really think things have now come to such a pass, that naval Officers may well be excused for speaking their minds. Under the present system of starvation, our dockyards may be compared to a spendthrift on a strict allowance; when his pockets are full of money, he does not care how he spends it; when his purse is empty he starves. Surely this is not a right state of things for a great country like England. Whatever a wise and prudent Admiralty think necessary, the country should provide money to pay for. There is no doubt we are a long way short of what we ought to be as a naval Power. We require therefore at present an extraordinary vote, and in the future an increase to the yearly Naval Estimates. Sir Edward Reed has given us a programme of the extra shipbuilding required, but before referring to it, I should like to enumerate a few other points which are of almost equal importance. *First*, those affecting the *personnel* of the Navy. *Secondly*, the repairs of the fleet. *Thirdly*, the construction of Colonial docks, and the protection of coaling stations. *Fourthly*, the furtherance of experiments. Now as regards the *personnel*, we are sadly in want of a more practical organization for the Navy, and I believe that this will not be brought about until we get properly organized naval barracks. Then again the entry of boys is not sufficient. It has been gradually reduced, until in the future we shall not have enough seamen. The number of stokers is also lamentably small for war purposes, and we have no organized reserve. The number of marines might be increased with advantage. The training of seamen and Officers in seamanship and naval tactics has been sadly overlooked, and it is certainly urgent that we should have squadrons of instruction constantly going. Lastly, the torpedo schools are not efficient, and money should be voted to complete them. Then as regards repairs of the fleet, no delay whatever should be permitted in replacing boilers when unfit for service. In other respects, so long as a ship is serviceable, let her be kept out of the hands of the dockyard, which only means extra expense. Again, old ships should not be too hastily condemned. Every floating vessel having a gun platform from which guns can be fairly fought will be of great value in a time of emergency. For instance, the "Royal Sovereign"

might be towed round to one of our mercantile ports, say Tynemouth, and kept in order by a few coastguardmen; there she would be a floating fortress of considerable value, and the basis of operations for the naval protection of that port. The question of protecting our coaling stations and docks abroad is, I believe, occupying the attention of the Admiralty at present, and we hope something may be done; and in addition to shore protections we should send out small ironclads (such as "Cyclops" class) to be stationed as the naval defence of such ports. Lastly, as regards experiments, money has not been sufficiently voted for experiments, and I believe I am correct in stating that this is the principal reason why the Ordnance Committee has not been able to push on with the new designs of guns; it has been kept short of money, and the required experiments have been delayed, consequently we are not so well off for guns as we ought to be. Again, many fittings are put into ships without being properly tested; the result is that many are useless, and only delay the completion of our ships of war. There should also be a torpedo-range; our supply of torpedoes suffers because we have no sufficient range for experiments with them. Sir Edward Reed has most ably treated the ship-building question, and with the greater part of his paper I very fully agree, more especially on the following points:—*First.* A prompt completion of the ships that are now being built. *Secondly.* The necessity for having auxiliaries as tenders to line-of-battle ships—this I consider an exceedingly important point. There are three means of protecting a ship from torpedoes: one by strengthening her bottom, and in this I do not quite agree with Sir Edward Reed's plan. I think there is too much armour, and that we cannot afford the weight; I would prefer doubling the thickness of both the outer and inner skin, and let it stand its chance. Another source of protection is by nets, about which there has been a great deal of controversy, but nothing seems to be decided. Then there is the protection afforded by such vessels as Sir Edward Reed proposes; and I must say I cannot conceive how a fleet, such as we must send to sea in time of war, can possibly hold its own, unless it is protected by at least as many of these vessels as there are battle-ships in the Fleet. *Thirdly,* as to Sir Edward Reed's programme, which appears to me very suitable and moderate, I am all for moderation and economy. I do not think we ought to do anything rashly, but we have come to such a pass, that we require this extraordinary vote, and we ought in all moderation to make it known to the country that naval Officers consider that such a vote is an urgent and imperative necessity. On the other hand, I do not wholly agree with Sir Edward Reed in his comparison of armoured ships. The "Inflexible" is a very powerful ship, and it does not seem right to take half her tonnage away in comparing her with the "Amiral Baudin."

Sir EDWARD REED: I only take the armoured tonnage.

Captain NOEL: After all, only the so-called armoured tonnage is here reckoned, whereas the ships are of about the same actual value. I think this is misleading, perhaps as misleading as the other comparisons referred to. If you are going to compare two fleets as regards their armour, I would suggest that instead of taking vessels of 15-inch or 12-inch armour, or whatever it may be, you should take the proportion of armour to the tonnage of the ship. For instance, take all vessels with more than one-tenth of their tonnage in armour protection, or with more than one-eighth of their tonnage in armour protection, and then you will have a fairer comparison of two fleets. What we want to arrive at is the relative amount of armour the ship carries. It is not very material where the armour is placed, and only a matter of choice whether you put it on the ship's side or on her decks. I must say I agree with Sir Edward Reed that placing it on the whole length of the side is best, and I would prefer the armour as distributed in the "Dreadnought" to that in the citadel ships. For armoured cruizers I believe in side-armour rather than deck-armour. Side-armour will afford a certain protection, and that protection is effectual; it keeps the shot out of the ship; even a small thickness of steel-faced armour will divert a great proportion of shot. The broadside of such a vessel must not be exposed more than is absolutely necessary, for, by keeping the armour at an angle to the enemy's guns, his shot will be deflected, which is not the case if the ship has a thin side and only an armoured deck underneath it. It is suggested that our armoured cruizers should be of considerable size, but I do not see why smaller vessels should not carry a certain amount of side-armour; 100 tons

on the side of a 4,000-ton ship would surely afford a considerable amount of protection. Unarmoured cruizers must always be open to serious damage. I should like to point out a mistake made by Sir Thomas Brassey, at Hastings; he apparently added the tonnage of the "Agamemnon," "Ajax," "Conqueror," and "Polyphemus" twice over in making out his total. I do not think the "Agamemnon" and "Ajax" need be added twice in computing tonnage; the real figures should be 427,370 tons instead of 453,170 tons, as was stated. I will conclude in the words of our lecturer:—"A policy of peace in Europe to be effective must, with us, ever be associated with ample naval power."

Adjourned Discussion.[1]

Thursday, November 27, 1884.

Mr. W. H. White (Sir W. Armstrong and Co.): A few days ago there appeared in the "Times" a letter cautioning naval architects against letting their differences of opinion hinder the common object which we have in view, viz., the increase of the strength of the Navy, and I am most anxious in anything I say not to go against the advice then given. But although at the outset I should like to state that I heartily endorse most of Sir E. J. Reed's recommendations as to the action to be taken, I must also as heartily state, with all respect for Sir E. J. Reed's opinions, that I dissent strongly from many arguments which he advanced in support of his conclusions. I think that his arrangement of ships is admirable in this sense, that it shows what has been done in England and in France in the direction of armoured ships since the French resettled their programme for their Fleet in 1872, and deliberately set to work practically to recreate it. I think that in many classifications that have appeared it has been overlooked that the date of 1872 in the French programme is a very important one. We see before us, I believe, a fairly complete list of ships which in England and in France have been laid down within that time, or at least which have been advanced from an early stage; and apart from all differences of opinion as to what may be called the armoured tonnage of a particular ship, it appears that we have gone five battle-ships to the bad in the time, which fact agrees with Sir E. J. Reed's recommendation that we should immediately begin with five battle-ships. Without any adjustment of rival claims in regard to fighting efficiency, I think the deduction is to be drawn, and I heartily endorse the recommendation that has been made. Then as to cruizers, I think that Sir E. J. Reed has stated a minimum number to meet immediate requirements. I am speaking, of course, of those vessels which he calls unarmoured cruizers, but which I am accustomed to call protected vessels. I think that he has named the minimum number to meet immediate requirements, and that is a number which might, with great advantage to the country, be largely increased at once. As one connected with private ship-building industry, I know that any recommendation about giving out orders to private shipyards may be looked upon simply as an appeal for employment and for pocket; but I beg members of this Institution to believe that I am not speaking at all in that sense. I am speaking in what I believe to be the interests of the country. There are now unemployed in my own district something like 15,000 men who can be usefully occupied for the benefit of the country (and what holds good on the Tyne is true also on the Clyde and other shipping rivers) in making up our arrears. The honest truth is that from 1872 onwards, the attempt has been made to work the English Navy with too little money. That is the simple truth. Whatever Board of Admiralty has been in office it has had to face that difficulty, and now the whole thing has broken down. Here we have on the French side a larger expendi-

[1] The Chairman gave notice that as Sir E. Reed would leave town to-morrow, the discussion would close, and his reply commence, at 5 o'clock.

ture, and the result is a more powerful Fleet in the immediate future than we shall possess unless we endeavour to make up arrears. Having said so much in agreement with Sir E. Reed (and I would now also like to say that with regard to torpedo-boats I also entirely agree with him) may I be permitted in, I hope, the best of tempers and without any personal difference, to express my views as to certain points in which I think he has not done justice to the English Fleet. In saying so I wish to speak as one who for five years occupied a position of some importance at the Admiralty, and who, conjointly with Mr. Barnaby, had to take the professional responsibility for the designs of all the ships that appear, from the "Colossus" downwwards, in Sir Edward Reed's principal table. I do not claim to speak impartially,—my own work is represented in those ships, and of course my opinion must be always associated with the fact that I have a personal responsibility in connection with the design; but what I wish to say is this: First of all it occurs to me that this method of estimating armour displacement, if it is to be taken also as a measure of fighting efficiency, must have something in it that is radically wrong. To illustrate the general remark I would simply say that, if we apply the same method to foreign navies, we find that the "Italia" and the "Lepanto" of the Italian Navy, close on 14,000 tons displacement or thereabouts, carrying hundred-ton guns, with armour of 19 inches normal thickness on the batteries containing those guns, with a strong armour deck (I believe I am right in saying four or five inches thick) would not appear as possessing any armoured tonnage whatever.

Sir EDWARD REED: They have none.

Mr. WHITE: Then if my understanding of the case is right, "armoured tonnage" and "fighting efficiency" are not interchangeable terms. Of course it may be said that nothing can take the place of side-armour; that is a view which can be maintained, and which I understand SirEdward Reed to favour. My own view does not agree with that. My own view is that in all probability side-armour, worked as it has been, and shown in the diagram in Fig. 3, is not likely to continue, and that the distinctive mark of the armoured ship in the future, as compared with the protected ship, will be the use of thick armour for the protection of the guns; that is simply a personal opinion; but if I am told to treat vessels like the "Italia" or the "Lepanto," because they do not happen to possess side-armour, as out of the list of effective battle-ships, it seems to me to involve some fallacy, and I think that fallacy is not very difficult to discover. It comes to this: the Italian constructors have preferred, at the expense of many thousand tons of weight, to put their protection in the form of an arched thick deck. They have done so of course in view of a considerable acquaintance with modern guns in their largest forms; they are the possessors of the most powerful guns in the world at the present, and they fire them; they know what the heaviest shells can do. They may not have fired them at a section representing the water-line region of the ship, and I quite agree with Sir Edward Reed that such experiments are desirable, it is not a matter that should be left to opinion; in that I heartily endorse his recommendation, but still there is good reason for maintaining their view. They gave effect to it in those two ships; they are going to give effect to it in other ships, and I ask anyone whether it would be wise or right to treat the "Italia" and "Lepanto" as non-existent battle-ships, in any computation of the strength of the navies of Europe.

Sir E. J. REED: I made no such suggestion.

Mr. WHITE: I simply wish to draw attention to this fact. I do not wish to misrepresent the lecturer, far from it. I wish to represent this fact, that we must always associate fighting efficiency with other qualities than side-armour in reckoning up the strength of the effective fleets of Europe, and I think that is an important thing to draw attention to. Now, as regards the disposition of the armour, I do not wish to enter into any detailed explanation, because Sir Edward Reed has been very careful to guard himself against more than the outline of his views, and I do not wish to enter into argument, but I will simply say this:—When the "Collingwood," which was the first of those ships, was designed, having regard to the sum of money available, to the speed asked for, to the armament to be carried, and to what was conceived to be the desirable protection of the vital parts of the ship, the disposition of the armour shown in Fig. 1 was that which, after the most careful consideration, not merely by the constructive staff of the Admiralty, but by

the naval Officers, and the right hon. gentleman who sits in front of me (Mr. W. H. Smith, M.P., was then First Lord of the Admiralty), was decided upon as being the best under all the circumstances, as associating the conditions of cost, speed, armament, and protection of the vitals. And further, arrangements were made and are existent in all those ships by which, if it is so desired in action, their ends can be filled with water above the armoured deck, to increase the protection and to decrease the liability to alteration of trim by the penetration of the light sides above water. Having said so much, I would only wish to add, having had the advantage of talking with many foreign naval Officers as to the fighting efficiency of English ships as compared with foreign ships, I do not find that they are disposed to make such a very liberal deduction from the fighting efficiency of the English ships, as is made in the table which Sir Edward Reed has put upon the wall. Now let me ask what is armour to do? I have seen armour-targets which have been fired at, and which have not kept out the shot, and I have seen what there was behind them. Undoubtedly, unless you get armour which does keep out projectiles, there is an immense amount of harm done behind. I appeal to artillerists who are familiar with modern shell fire, as to which is the most fatal thing, the mitraille from a damaged armour-target to what lies behind it, or the splinters that come from the explosion of a shell in a ship. I think that in these discussions as to the utility of armour the evil that is wrought behind weak armour in consequence of its weakness is often overlooked. In saying that let me add that I am not in any way an advocate for the abolition of armoured ships; I do not mean that at all. And further let me say, speaking on behalf of Sir William Armstrong, who is not here, that he has not advocated and does not advocate the abandonment of armour for English ships. His wish has been, seeing that there was a great disposition in the public advocacy for strengthening the Navy, to concentrate attention upon armoured ships, to draw attention to the fact that protected ships were a necessity in the Navy, and that their numbers should be very largely augmented. Further on his behalf, he being absent, let me say that he has a great regard for the fighting efficiency of protected ships. He puts a high value upon their fighting efficiency, and he does not advocate the abandonment by England of armoured ships. With regard to protected cruizers the Secretary was good enough to ask me to favour the Institution with diagrams of the "Esmeralda," and I owe thanks to Sir E. J. Reed's courtesy for allowing us to add these diagrams to those which have been put upon the wall. There is a diagram of the "Esmeralda" showing the armament, and there is also a diagram showing the position of the protective deck, and the height to which the coal lies upon it when the bunkers are filled. Members will find in the Library the full photographs, but the Secretary thought it would be desirable that these diagrams should be exhibited. We do not look upon the "Esmeralda" as the typical protected ship. We are building two ships at the present time which I have had the honour of designing, with decks three inches thick in steel. They are ships heavier in armament, stronger in protection, larger in coal supply, more powerful in guns and fighting efficiency all through, but they are also larger and more costly. Let me simply on behalf of the firm with which I am connected, and as a comparative outsider (I did not design the "Esmeralda," she was far advanced before I left the Admiralty), say that in my judgment the "Esmeralda" represents up to date the best cruizer that has been produced of 3,000 tons displacement, and that is all we claim for her. I do not think that any one can show me a ship of 3,000 tons displacement which has a higher speed. The living quarters are splendid; the speed is attained with ease, and she is altogether a vessel which in fittings and finish is a war-ship. The protected cruizer of the future is in my judgment a more powerful vessel still. She will be stronger, her deck will be thicker, and in all respects I believe she will be more available as an auxiliary to the battle-ship of the future. Those are the most important points of which I wished to speak; there are others which I had noted, but I do not wish to trespass upon the time of the meeting. I would say in closing, as I began, that I hope the recommendations of Sir E. J. Reed will be given effect to by an increase in the Navy.

The Rt. Hon. W. H. SMITH, M.P.: As you have been kind enough, Sir, to ask me to say a few words upon this very important question, I will venture to trespass upon the time of the members of the Institution for a very few minutes. I shall not attempt

to follow my friend Mr. White on a technical subject, on the points which he has raised with so much ability. There is no question that, after my friend Sir E. J. Reed, there is hardly a person in this room who is better able to express an opinion upon the relative qualities of ships and their fighting efficiency, and the way in which they should be designed. But it is not my wish—I am sure gentlemen present will see that it would hardly be becoming in me—to enter upon a discussion of that character. I shall rather endeavour to deal with the question which Sir E. J. Reed has raised, with so much ability and, as I think, so greatly to the advantage and to the interest of the country at large. The title of the paper is: "What are the most urgent measures to be taken for increasing Her Majesty's Navy?" I do not suppose there are many persons who have taken the trouble to investigate the question, and to consider for themselves the duties which fall to the Navy, or the vast interests of the country in the maintenance of peace and the security of commerce; I say there are exceedingly few persons who do not hold the view that a permanent increase in the strength of the Navy has become absolutely necessary. In saying this, I desire to say it not as a party man, but as one who for a time was charged with great responsibility in the administration of the affairs of the Navy, and who acquired in that way information and knowledge which he did not in the first instance possess, and who has since perfected that knowledge by observation and by comparison of the strength and the duties which fall to the Navy of this country with the strength of the navies of other nations. Sir, I have come to the conclusion that an addition, a sensible and material addition, to the strength of the British Navy is essential to the peace of the world. I have no doubt there are persons who will say that this is the expression of a gentleman who now holds different opinions from those which he professed four or five years ago. Let it be so; if it be necessary that I should have some mud thrown at me, it is better that an individual should be charged with apparent inconsistency than that he should go through life with the conviction that he had failed to express an opinion arrived at deliberately, and as the result of the circumstances in which he was placed. Sir E. J. Reed has given us most valuable information. He has drawn our attention to the fact that there is great delay in the building of ships, and he has insisted especially upon the cost to the country of that delay. Now, Sir, I do not think that the cost is by any means the most important consideration involved in this question. There is a statement on the wall of a large number of powerful ships which have been built. In the Returns issued by the Admiralty from time to time, and in any facts upon which reliance is placed to justify the policy of the Government, those ships and other ships which are being built are relied upon as a positive present immediate contribution to the strength of the Navy; are referred to as something on which the country can rely in time of emergency. Well, Sir, there will be a time in the future when these ships will be available, but as I read the documents which have been presented to us, only one out of the eight ships building is stated in that paper as at all likely to be afloat and serviceable to the Navy in the course of the next year. The impression in the public mind is that instead of one, the whole of the eight ships are a positive present and immediate contribution to the strength of the country. They are nothing of the kind; they are of no more value than so much iron or so much wood in the bowels of the earth at the present moment for an immediate war. And perhaps I may be allowed to say that I take a somewhat different view of the duties of the Navy from those which appear to be taken by persons occupying official positions. I think that the Navy with the Army ought to be ready for any work which can reasonably be expected to fall upon them at any moment. We know that wars in these days come at a very short notice. I may be forgiven if I repeat myself by saying that I drew attention not long ago to the fact that the great Franco-German war broke out at three weeks' notice after a statement by a statesman in the House of Commons and a statement in the French Chambers that peace reigned throughout the world. What is there to prevent a war breaking out in three weeks which may affect England? What ships have we got? What men have we got? What guns have we got? What arrangements are in existence for the protection of the interests of England at such a short notice? For myself I insist that no ships, no guns, no men, should be taken into account as available now for the service of the country unless they are actually in the first reserve, unless they are actually

available in the event of war arising in the manner which I have suggested as possible. It is childish to suppose that we should have notice, that we should have time for preparation. Nothing of the kind will take place. It is childish to suppose that the nations of the world are so considerate of the interests of those whom they are going to attack that they will give us ample opportunity for preparation, ample time to resist the blow when it is made. If, then, there is any intention to make war on England it will come suddenly with but short notice, and as reasonable and sensible men we ought to be prepared to receive the blow and return it. I have said that I hope this will not be made a party question in any way. So far as I am concerned I shall certainly endeavour to avoid any attempt of the kind. It is rather with the system than with a party that I wish to contend. It does appear to me that unfortunately great questions of this character, vast questions concerning the interests and the security of the country have been permitted to be dealt with during the last twenty or twenty-five years as questions which concern the interests of those only who might happen to be in power. I venture to regard such persons as trustees for the time being for the country at large. We ought to insist on it, that in the conduct of the great Services the Army and the Navy should be altogether irrespective of the petty personal interests of gentlemen either on one side of the House of Commons or on the other. What we want is some system which will embrace the whole of the great duty which lies before the Government of this country, not as affecting individuals, but as affecting the whole nation, something that will rise to the necessities of the case and see that the interests of the country are properly cared for. What I advocate is a condition of things which shall conduce to the peace and security of the world, which shall not be at all aggressive, but give the greatest possible promise of that time of prosperity which we all wish to see, and which we trust may last as long as possible. My friend Sir E. J. Reed has gone into the question of armoured ships, unarmoured ships, and torpedo-vessels. There can be no doubt that we require armoured ships. There can be no doubt, looking at the strength of foreign nations, which has been so rapidly developed during the last five or six years, so abnormally developed, that we require a considerable addition to our armour-plated ships. I have asked the question of some of my friends whether the First Sea Lord of the Admiralty has a scheme in his mind (I suppose he has) for the protection of the country in the event of war, and I should like to know whether there are ships to meet all possible combinations of ships that may be brought against us. I should like to know whether there are reserves to meet the inevitable tremendous loss which must be involved in any naval combat. I should like to know, looking at the development of fast cruizers, whether we have cruizers sufficient in the judgment of the First Sea Lord to deal with any of those that might be preying upon our commerce. I should like to know whether these conditions are complied with irrespective of the fancied security which the Treaty of Paris and other Conventions give to us with reference to the duties and rights of neutrals. I may now be saying something which may possibly be regarded as an objectionable statement, but as a man who is to some extent responsible for the security of the country even now, having held office before, I cannot place the least reliance as a security upon any paper engagements made between the Powers in the past. I believe that when the necessity arises—the supposed necessity—the weaker Power, weaker in ships and guns and men, will avail itself of any means whatever to inflict loss and injury upon us. Therefore I say there is only one course to be taken, and that is to secure the country as far as we can do it against any probable danger of mischief from a combination of the Powers, or an attempt on the part of the enemy to avail itself of the resources in ships and in men which it will find on its hands, although they may not be regular men-of-war. I beg to apologize for having trespassed upon your time. I have spoken from a profound sense of individual responsibility, and I repeat the warning which I have ventured to give, that this question ought to be dealt with as a national question. I would also repeat, if I may be permitted to do so, the words which fell from Sir Spencer Robinson yesterday, that we ought not to discuss the merits of one ship or another, or of one class of ships as compared with another class. We want pretty nearly all classes and types, and we should combine in an

endeavour to inform our fellow-countrymen of the condition in which the Navy is at present, and of the real necessity which exists for the augmentation that Sir E. J. Reed desires.

The CHAIRMAN: I should like to emphasize the last words of Mr. Smith, that we should not discuss the details or the merits of one ship as against another, but confine ourselves to the general question before us.

Admiral BOYS: We have had a most interesting lecture, and so far a most interesting and important discussion. The discussion has hitherto been carried on by senior and responsible members, but I hope that there are some juniors here who will take part in it. It was observed in the "Times" four years ago, and I think the remark has been quoted by Sir Thomas Brassey, that a naval scare is one of the easiest things to be got up in this country. It is one of those things which usually come when a change of Government is imminent. We have nothing to do here with the change of Government, the only question with us is whether there is not always ground for the scare, and if there is ground for it, it is right that it should be brought forward. That is the position in which we happen to be now. We may be under what you may call a scare, but there is good reason for it, and it is brought forward at a timely moment. Only last week I was looking over some old family papers, and curiously enough I came across a letter from my father dated 1799 (he was then a midshipman in the "Robust" at Torbay), written to his brother who was in the Military Academy at Woolwich. In that letter he says, "We are lying here with fifty-four sail-of-the-line, and there are eleven more expected round from Plymouth." That was our home fleet in 1799. But what were our interests then as compared with our interests now? What was our commerce, what were our Colonies then? I believe at the present moment we have one thousand million pounds worth of British property on the high seas. Is our Navy or is it not in a proper state to protect that property? There is but one answer to the question. Sir E. J. Reed began by observing that no unofficial person could do full justice to the subject. That is perfectly true: no unofficial person can have the means or the information before him; he does not know what we are doing ourselves, and he does not know what foreigners are doing. I should like to ask Sir E. J. Reed a question with regard to this matter of pounds, shillings, and pence as given in his tables. He charges instalments of interest upon the fourth, fifth, and sixth years of ships being built. It strikes me that that should not always be the case. Suppose after the third year when a ship should have been built that she is not wanted, but would be simply put into the reserve and remain there: in that case I conceive that it is not consistent that such a charge should be made—her services not being required. What we want is that ships should be quickly built and immediately launched. A very few weeks ago the Cunard ship "Umbria" was launched, and this very day we have heard of her arrival in six days and a few hours from New York. Perhaps Sir E. J. Reed will be kind enough to put the matter before us a little more clearly. With regard to the "Inflexible" the lecturer has said, "When, however, the 'Inflexible' question arose there were so many naval Officers holding official and highly responsible positions at the Admiralty, that I have not since felt it necessary or desirable to further press my views or apprehensions." I should like to explain, as one of the Officers in question, that my opinion was not so much expressed upon the actual construction of the ship as upon what might possibly happen to her. It was said that if the ends were demolished by shot and shell, the ship would become dangerous from want of stability. My opinion was and still is that such a condition was practically impossible in any naval engagement. Gunnery people will perhaps support me in saying that in a naval engagement such a thing as destroying the ends of a ship could not happen; although perhaps it might happen if a ship were lying for a considerable time before a battery of fixed guns. My opinion was given upon that point, and not upon the actual construction of the ship. The term "protected tonnage" is a curious one, and the question is a curious one. It is one of the anomalies that occur when comparing one ship with another. I do not profess quite to understand it. It seems to me something like the old case of the skipper and the boatswain. An old collier was running on shore and the boatswain let go the anchor without orders. The captain said,

"What are you doing?" He replied that "he was looking after his end of the ship, and did not know anything about the other." I am not quite clear how I can take a part of a ship in tonnage as protected and the other part as unprotected. I think it is an anomaly, but I will not go further into the question. We are told by Sir E. J. Reed that Sir T. Brassey says that classification is difficult. Unquestionably it is. The classification of different types of ships is certainly difficult. We cannot place a proper value upon different conditions of a ship and take them altogether. One ship has a little more armour in one place, and another has a little more in another. When we have the maximum thickness of the armour given perhaps that maximum thickness only covers a small portion of the ship. I know one or two ships where there are 14 inches of armour, but there are not a dozen plates in the ship of that thickness. There are so many conditions in comparing ships that a comparison of different types cannot possibly be made. There is only one comparison that can be made in ships at all similar, and that is in the number of ships. This is certain—that whatever comparison is made we should have an overwhelming preponderance in every type of ship. With regard to the maximum thickness of iron mentioned by Sir E. J. Reed, may I ask whether that is iron protection or compound-armour protection? If we take steel and iron combined we may say that it adds 2½ to 3 inches of armour to a ship with 18 inches iron protection. With regard to unarmoured cruizers, I am decidedly of opinion, that whatever cruizer we have she must have the highest speed—whatever auxiliary Sir E. J. Reed produces—she must carry a gun of some description. I beg personally to thank Sir E. J. Reed for bringing this lecture before us. He has proposed an increase to the Navy on the lowest possible scale. There is, however, one item that I think he has left out—I mean the item of gunboats with one heavy gun for the protection of our home ports.[1]

The CHAIRMAN: I am informed that Mr. Norwood, M.P., is present, and as he was a member of the Committee on Contracts and Repairs of Ships, and might desire to make some observations, the present would be a convenient opportunity for his doing so.

Mr. NORWOOD, M.P.: I assure you, Sir, that I am taken at a very considerable disadvantage in being called upon unexpectedly to say a few words on the present occasion. In point of fact, I came here to learn, and certainly I was not prepared to offer an opinion in any shape. With reference to the question upon which Sir E. J. Reed has laid so much and so satisfactory a stress, the unfortunate delay that takes place in the construction and finishing of our ironclads, I, as a member of the Admiralty Committee, last year formed a strong opinion upon the subject. In fact, that small Committee, which with one exception was composed of practical men connected with the mercantile navy, either ship-builders or owners, were very much struck with the very unbusinesslike and unsatisfactory state of things when we found vessels that were designed and might be finished in the course of three or four years were held over for six, seven, or eight years, with alterations in the design consequent upon the uncertainty with respect to the armament with which those vessels were to be fitted. We reported very strongly against that state of things. It is not only extremely wasteful in the pounds, shillings, and pence point of view—that is by far the least important aspect of the question—but it is a most painful circumstance that when in the House of Commons estimates are voted and approval is given to a certain programme for the construction of vessels, those vessels, which it is hoped at an early period will be ready to take part in the actual defence of the country, are allowed to remain in an incomplete state in consequence of the uncertainty with respect to their armament. Our recommendation went to this extent, that the responsibility for the armament of men-of-war should be placed directly and solely upon the Admiralty. We think that the Admiralty is responsible for keeping up our Navy to the proper point. They are responsible for recommending to the country the proper type of vessel. We think it is an unmercantile and unsatisfactory arrangement that the Admiralty should have to consult a conflicting body that cannot have the same objects and interests; that they should be dependent upon the War Office. We recommended that the entire responsibility

[1] I should like to have touched upon the gun question, but time would not allow.—H. B.

should rest upon the Admiralty, but that the Admiralty may employ, if it thinks fit, the War Office for the supply of such guns as it requires. I do not say that it would be wise to cut adrift altogether the present connection between the Admiralty and the War Department, but I do think that if it is possible to obtain satisfactory armaments from private mercantile firms, the Admiralty should have free scope to carry out the arrangement. As to the fittings of men-of-war requiring armament, we were not disposed to support the practice that has prevailed for several years past, in confining our orders for hydraulic and other machinery to a very great and important house in the North of England. We think that that house deserves the thanks of the country for the services it has rendered, and hope that they will always be called upon by the Admiralty for assistance in supplying this machinery; but we think that the large range of engineering and inventive talent in the country, of a mercantile character, should be in future largely called upon in competition with the firm to which I have alluded. There was one point that we came to a unanimous conclusion upon, namely, that the construction of men-of-war could be safely left, in a large measure, to the mercantile shipbuilders. The Committee had abundant evidence from the Constructive Department of the Admiralty (which would naturally regard the dockyards as superior to private yards in that respect), that the quality of the work turned out by the large mercantile firms was fully equal to that of the dockyards, and that certainly the cost was considerably less. They recommended that while a large share in the construction of the vessels should be committed, by tender or otherwise, to shipbuilders in the out ports, the repairs should be almost entirely confined to the dockyards. Men of business know the extreme difficulty of making a contract for repairing vessels, where the necessity for repair cannot be seen upon the surface, and where the vessels have to be opened out before it can really be ascertained. We know that economically it is a bad system to enter into contract by piecework, and we strongly recommended that the dockyards should keep the repair of vessels within their own hands. I am very glad to find Sir E. J. Reed proposes fast armoured and unarmoured cruizers, because, as a shipowner, I am certain that to rely upon the mercantile marine as vessels of a fighting character is a perfect mistake. Our vessels have progressed in size to a degree scarcely contemplated by the most sanguine men, but I do not think that they are vessels that can be relied upon in the slightest degree for fighting purposes. I do, however, think that we may, as a nation, rely much more than we have hitherto done upon the mercantile marine for transport purposes. Any gentleman who has had the opportunity of seeing the magnificent vessels for the Transatlantic lines and the vessels of the Peninsular and Oriental Company for carrying passengers, must be aware of the splendour of those ships and the numbers which have been lately constructed. I think, then, that we ought as a nation to confine the operations of the Admiralty to the construction of fighting ships, leaving the transport to the mercantile marine of the country. We went into the question of the cost of our transports, belonging partly to the India Board and to the Royal Navy, and we went into the enormous expenditure upon the "Orontes," which was lengthened at a cost far exceeding what would have been the cost of a new ship of the same dimensions. We think it would be wise, economically speaking, if we did not fritter away our money and occupy our dockyards in the construction and repair of vessels which are not fighting vessels, when the same service can be obtained as effectually and far more cheaply by going to the mercantile shipowners in the open market. I take a deep interest in this subject. I believe that our naval defences have fallen considerably below what they ought to be. When I look at the enormous increase of our mercantile steam tonnage within the last six or seven years, amounting to 41 per cent., when I remember that there is scarcely any portion of the globe, scarcely any harbour or river, that does not receive our Mercantile Navy, I do think that we have not got a sufficient protection for those ships in case of hostilities arising. I therefore welcome with great pleasure the interest now taken in the Navy. With regard to the question of cost, I have sometimes wondered whether I could guess the amount which should be asked for in the way of extra naval expenditure; and a fortnight ago I told a gentleman, high in office, that I thought he ought to ask five millions of money to be spread over two years. Now, when I deduct the 1,100,000*l.*

that is to be expended after the first two years, I have the pleasure of finding that my hon. friend Sir E. J. Reed and myself are within one or two hundred thousand pounds in our estimates of the amount that ought to be expended.

Captain ORDE-BROWNE, late R.A.: I should like first of all to say how very much everyone must have sympathy in what has been put forward, seeing the extreme necessity for a great increase of the Navy. I should also like it to be understood that I think the estimates put forward by the Admiralty and by Sir Thomas Brassey extremely mischievous and misleading. I am going to raise a question of classification, and it might be thought that I was doing that because I had some interest in defending the Admiralty, so I say that first. With regard to the classification, I am inclined to believe that Sir Edward Reed expected some question to be raised with reference to the way in which he has classified the armoured and unarmoured ends, and it is simply that question that I want to raise now. As I understand it, our needs are based by Sir E. Reed mainly on the total of our armoured ships, and the objection to the unarmoured ships and to ships unarmoured to the water-line amounts to the fact that water can enter and sink the ship. I admit that taking these as being the main features he might have gone further, because to put down the armoured ships as equal to the armoured tonnage really does not represent the case badly enough, because each armoured ship, as in the case of the "Inflexible," is, as it were, attached to the unarmoured ships, and when they sink the armoured ship must go down with it; but if the unarmoured part does not sink, then we have to remember, on the other hand, that she remains intact with all her fighting features—guns, engines, and everything else. It does appear to me that the classification must be wrong in some way. If the ship does not sink she remains with her guns, engines, steering gear, everything else all complete, and therefore the fact that she could have the unarmoured parts pierced would not take away half the efficiency—it would, in fact, effect comparatively little. But in action is that the way in which armour-clad ships are disabled, or in which unarmoured ships are disabled? Is it commonly the case that they are sunk? Happily we have had very few instances to guide us. The drawing of the "Esmeralda" suggests her predecessor—the predecessor of the "Esmeralda" was sunk; the "Huascar" was knocked to pieces, but not sunk. The "Huascar" had an armoured water-line, the "Esmeralda" had not. But although that looks like Sir E. Reed's supposition on the face of it, if you examine it more carefully it was not so, because the "Huascar's" armour was so thin that the shells acted in very much the way as if there had been no armour at all. If the armour is less than half the diameter of the shell you may expect the shell to act in that way. In the sense of water entering, there is no doubt that armour is a very great protection along the water-line, even when it is penetrated, but if it is so thin that the shell goes through then that does not happen, and I suppose the "Huascar" and the "Esmeralda" were very much in the condition of ships that had not armour along the water-line. Neither of them was sunk by firing. The "Huascar" was actually disabled because her guns were knocked to pieces, and her steering-gear disabled. All these things are protected by the armour. Now what does this bring us to?

The CHAIRMAN: What we want is to deal with the British Navy *en bloc*, not with details of particular ships.

Captain ORDE-BROWNE: I want to take the classification on which the general estimate of the strengths of the fleets is based.

Sir EDWARD REED: I have not discussed at all in my paper the qualities of these ships. I have simply taken the amount of displacement covered by the armour.

Captain ORDE-BROWNE: If that is the case some third class is wanted for ships, as Mr. White reminded us. You have the "Duilio," the "Dandolo," the "Italia," and "Lepanto," and something is wanted to cover the latter class of ships. Of course the whole strength of the Navy, as apparently taken by armoured ships, does not embrace that class.

Captain P. H. COLOMB, R.N.: In addition to our full agreement in the vote of thanks which we ultimately pass to the lecturer, there is one point in which we shall all agree, and in which all previous speakers have agreed, and that is that Sir Edward Reed's proposals are very moderate. I think it was also plain to us all

that now that this crisis is come we must waste some money. We have ever since 1870 been dealing with the Navy at a starvation point, and then we have, everyone of us, come to the conclusion that the starvation point is the proper condition for the British Navy. We have to make up for our misdeeds in past years as quickly as possible, and we shall be bound to waste money in making it up. But I think we shall waste less money if we stick to approved types of ships. That is a point on which the whole Navy will be agreed. We had better not go at this moment into experimental or untried types of ships. As Sir John Hay stated yesterday, the main thing is to get the money to spend, and to induce the country to understand that a larger sum of money than has been spent up to this time is to be spent in future. Therefore my heart warmed to Sir Spencer Robinson's remark when he appealed to naval Officers, and, I presume to others, following his letter in the "Pall Mall Gazette," not at this time to go into disputes over niceties, but to urge the country to spend the money and to get a sufficient number of ships of any approved type, whatever it may be. But Sir Spencer Robinson was right in saying that, as a rule, naval Officers have very divergent opinions. I think it is more their misfortune than their fault. I only know one way in which these divergent opinions are to be corrected, and that is by pursuing experiments to any extent, and if Sir E. Reed had added to his estimate 500,000*l.* a-year to be spent entirely on experiment, I am perfectly sure that that would have proved to be a real economy. When one comes to think even of the 4,000,000*l.* a-year which Sir John Hay proposed that we should spend instead of the smaller estimate, we are all agreed to give our quota in order that the desired result may be obtained. I hold from my standing in the Service a very good post. The Government would deduct for the purpose of spending the four millions which Sir John Hay asks should be spent, from 12*l.* to 15*l.* out of my pay, and I must say I should be exceedingly glad to give that 12*l.* or 15*l.* in order to see the Navy put on a proper footing. We are all agreed to urge the rapid completion of ships in hand. Let us put our full strength on it and get them out of hand as quickly as possible. Coming now to a controverted point, and expressing my regret that it should be necessary to touch upon it at all, I do not think Sir E. Reed is quite fair in saying that naval Officers are generally in favour of the "Collingwood" method of armament in contrast to that carried out in the "Duperré." I do not think naval Officers, as a rule, have sufficient data to go upon to express any strong opinions at all upon the subject, and I think that though they may favour the one or the other, yet if they had the responsibility on their shoulders very few of them would express an opinion which might have to be carried out unless they had further data than is at present before them to go upon. There is one urgent necessity at the present, and that is that you should associate in some way those who have to live in and to deal with the ships in their initiation and design. I know it is a point that has been before the Admiralty once or twice, and in point of fact Mr. White whispered into my ear, just before I rose, something to the same effect, that there should be in some way a greater connection between the constructor and the active service. It is greatly on account of that want that so many differences of opinion arise. The overwhelming majority of the Navy will tell you to-morrow that if you want to build five ironclads of the right type the "Dreadnought" is that type. I never heard naval Officers give another opinion about it. And, moreover, the Navy is not now fully informed as to why the "Dreadnought" type was departed from. The Navy will not follow Sir E. Reed into the niceties of the distribution of armour. We are not, as I said before, prepared to do it. We are much more likely to go with Sir Thomas Symonds, and to say that the question is a matter to be decided by experiment. We must build the necessary targets and the necessary ships, and we must fire at them and see what is the result. The Navy, I think, generally is content to remember that some 60 lbs. of powder is required to put a shot fairly through 12 inches of armour, and then it knows that 60 lbs. of powder must have a certain sized gun which must occupy a certain space, and will compel your enemy to build ships of a certain size to carry it. We are beginning to think, as was stated by one speaker, that the protection of the men by armour is becoming an important point. I believe it is a growing opinion in the Navy that it is not fair to oppose the men with unprotected guns to the enormous

number of machine-guns which are now brought to bear upon them. Then I think we are also agreed in the Navy that the strength of a ship cannot be measured entirely by her armour; her strength is in attack as well as in defence. You can, if you have a sufficient number of guns, keep the enemy's fire down, just as well as if you had a belt of armour to do it. And then we also recollect that ships may be taken without being destroyed, and they may be destroyed by other weapons than guns. We are all agreed as to the necessity of building five or six armour-clads of any approved type. We shall not make a very great mistake whatever we do as long as we do that. The Navy will also go to a great extent with Sir E. Reed in the necessity for torpedo-boat catchers; that it is a thing which ought to be gone into as soon as possible. The armoured cruizer, on the other hand, is a more debatable ship. There is no question that discussion will always be raised about her, and I myself would rather go to work now and build some ships about which there arises less discussion. I believe we have sent the "Agamemnon" to China, and I feel perfectly sure that if the "Amiral Baudin" and the "Amiral Duperré" were to go to the Cape with hostile intentions, we should send the "Colossus" and the "Edinburgh" after them without the slightest hesitation, and in that sense I should think the "Colossus" and the "Edinburgh" would be protected cruizers, and very good ones. I must say a word with regard to these small vessels, and I am sure the Navy is in agreement with our lecturer there. We deplore the want of locomotion in our smaller vessels. We know perfectly well that if war breaks out these wretched little creatures—bug-traps, as we call them—will be shut up in ports, and be unable to do anything. They want greater power of locomotion, and they ought to have it. There is one point about Sir E. Reed's proposals which strikes me, as it must strike a good many people, and which is common to all proposals, that they rest upon opinion in this case of a gentleman very eminent, pre-eminent I might say. But after all is said and done, the main part of his proposals rests upon opinion, and it is time we should pass away from opinion and go to facts. We know what enemies we have to deal with. We know where they are. Do we know, if war were declared in a fortnight, what we are going to do to protect ourselves? Until we have a settled plan founded on the geographical and other position of the foes with which we are to come in contact, we shall never have settled Naval Estimates of proper dimensions. The moment we have a settled plan, and the moment we go on correcting that settled plan by experiment and trial of all sorts, we shall begin to find that we shall have a backbone running through the whole of our system of construction, which it is one of the lamentations commonly heard in the Navy does not exist at the present time.

Captain J. C. R. Colomb: In the first place I wish to join in the general gratification we have felt in the opportuneness and ability of the paper, and I wish as far as that goes to sum up my personal opinion of it by saying that the money proposed to be spent by Sir E. Reed is inadequate. I may say that I regard it as a golden bridge for retreat from a fact that ought to be faced, and having said that I will now offer one or two remarks, confining myself to two single lines of the whole paper. Sir E. Reed says, "The British Navy ought to possess some excess over the French Navy in ships armoured with 15 inches of armour and upwards." Now I say that in every class of ship compared with France, we should have "some excess" over France. The pith of the whole matter lies in what definition you can give to the words "some excess," and unless you can give some definition to that I say you do not know clearly what money you ought to spend. I wish to say this again, that it is facts and not theories by which you reduce that "some excess" to £ *s. d.*, and I say that it is the principles of sea strategy which alone can answer that question. The relative strength of national fleets depends upon the strategical necessities of their national sea possessions. Take for instance the case of France. You cannot compare the maritime position of France with that of England. Sir E. Reed proposes five new cruizers, and he does not allow one to the South Pacific, but if we cast our eyes to the South Pacific alone we find that British interests in annual trade there are one hundred millions, while those of France are not two and a half. I have stated that I believe that to measure this "some excess" you have to go to

strategical principles, and I believe it is strategical principles that rule your classification of ships, and that it is tactical requirements that will be the true guide to the development of the particular type and class. Well, now, I say that we can only make out the "some excess" in this way. Take France, for instance. I say it is first by the strength of France's line of battle; secondly, by the geographical position and local circumstances and means of defence of the offings of her war ports; and, thirdly, by facts relating to the constant reliefs required by a fleet to keep its station off enemies' ports. Now, I venture to submit that this is the only standard by which you can measure the "some excess." This is not the standard you are applying: it is not the standard of your naval policy now. Having refused attention to the three facts that I have mentioned means this, that you have not got the line-of-battle ships to take up that position before French ports or to maintain it for a week. As a matter of fact, although blockade was your traditional policy, the policy by which you won your victories, you have now departed from it. I hold in my hand a paper written by Mr. Barnaby, a man whom all esteem and respect, who is an official at the Admiralty, and is not likely to put forward any theory that was not adopted, and I find in that paper read in 1877 that he laid in order before us the duties to be performed in naval war, and he divided them under ten heads. The first section is "defensive," the last section is "offensive," but there are ten heads altogether, and the "locking up of your enemy's fleet" is the ninth. Now, I do ask naval Officers to say distinctly, is the policy of this country to be changed from what tradition has proved as the best? I ask you to say distinctly and in one voice if you are not going to adopt that policy what are you going to adopt? I myself believe that if you do not follow that as your national naval policy you are in "confusion worse confounded," and you never can measure what that "some excess" means with an Empire extending over the world, and a commerce such as the world has never seen before. I can tell you what my own conclusion is from measuring this carefully: that if you want to have reasonable security for the British Empire and British sea trade, you cannot do it unless you are prepared with a line-of-battle force capable of producing that moral effect which will make the enemy dislike to leave his ports, and I say you cannot do it with anything less than a line of battle double that of France.

Admiral Sir LEOPOLD MCCLINTOCK: Mr. Chairman and Gentlemen: I do not propose to occupy very much of your time. The lecturer, to whom we are very much indebted for the lucid paper he has given us, has, with very little difficulty to himself, shown that the British Navy, as it is, is utterly incompetent to protect our Colonies and trade. He has not only shown us that, but he has shown us the necessity we are in of protecting our more valuable ships. The Navy will have quite enough to do to take care of itself in a sudden outbreak of war, and the lecturer has shown us the necessity for having fifteen auxiliary cruizers, torpedo-catchers, for the purpose of protecting fifteen of the most valuable and most powerful of our own ships. The introduction of the torpedo has very largely revolutionized the small craft which are necessary in every navy. I think every naval Officer will agree with me, that of our small craft, sloops, gunboats, and gun-vessels, at least four-fifths are obsolete, and in war-time dare not venture outside of our own harbours. I think it will be known to most naval Officers that on the opposite side of the Channel and the North Sea there are, or very shortly will be, a couple of hundred first-class torpedo-boats, all partially armed by machine-guns. I think that in the future, small vessels will act a much more important part than they have done in the past. Let us assume a sudden outbreak of war. How many hours would it take for our shores to be visited and our coasting trade annihilated, the very first night after the declaration of war, from the opposite side of the Channel; and how is this to be prevented? We have done very little in the way of adding torpedo-boats to our Fleet, and nothing in the shape of anti-torpedo-boats or torpedo-catchers. I simply wish to mention this. I agree with Sir Edward Reed as far down as he thought fit to go, but still I think it is an urgent necessity that we should go a good deal lower, and have more small vessels. If he had added one million to his estimates for this class of vessel alone, he would still have been under the mark.

Captain FITZGERALD, R.N.: In these days of naval science, and in the presence of so

much ability, it may be considered presumptuous in a mere sailing Captain to offer any opinion on the merits of this paper, and I would not venture to do so were it not that Sir Edward Reed has done the profession the honour of asking their opinions on one or two points. As to the general merits I shall not waste much time, because they speak for themselves. Everyone is agreed that something must be done, and the only question is, what is to be done? Sir Edward Reed in a very clear manner has put forward what he thinks ought to be done, and invited our opinions upon it. The first point I wish to speak about is the question of delay in building ships. I venture to agree with the right honourable gentleman, Mr. W. H. Smith, in thinking that the statement in the paper as to the loss of interest does not at all represent the loss to the country in the delay in building ships. It seems to me to be a question of either you have got it or you have not got it. There is a thing that you want; it is either ready on a certain day or it is not ready; if it is not ready it is of no use to you; and a ship on the stocks is no more use to the country than an unhatched egg to a woman who wants to sell her chickens in to-morrow's market. I saw a letter in the "Times" some weeks ago on this question of delay. It struck me as having the authority of some one in the Admiralty office, because it was defending delaying the completion of ships on the ground that it admitted of the latest improvements being embodied in those ships; that struck me as being the most enormous piece of folly ever enunciated. If you are to keep a ship six years in building instead of three in order to put the latest improvements in, why not make it ten years, why not twenty years? No one supposes that we shall ever arrive at finality in the different instruments of destruction, and if it is reasonable that the ship should take ten years to build, it is quite as reasonable for twenty years, as far as I can see. I was going to make a remark about the comparison of these ships, but it already seems to have been thrashed out. I venture to think the comparison was not quite fair, and that if these ships have so much of their ends unprotected and the same tonnage and displacement as the French ships, have they not something else to compensate for their want of armour? I mean some fighting strength?

Sir E. REED: What?

Captain FITZGERALD: Have they not high speed or more gun-power, or more coal carrying powers? If not, it would seem to be a ridiculous thing that they should be put up in that way floating on the top of the water to be blown along like bladders. Perhaps Sir Edward Reed will tell us if there is anything in them, more coal or more guns, or more speed, in order to compensate for the loss of armour. Sir Edward Reed has asked the opinion of naval Officers as to whether the torpedo-boat catcher with one gun could not take the place of the present small craft of the Navy.

Sir EDWARD REED: To some extent.

Captain FITZGERALD: I think they could. In war-time I think they could altogether. I can imagine nothing more miserable than our present small craft, and only those who have laid alongside foreign ships in our ten-gun or three-gun "pelters" can know the mortification that naval Officers feel at being in these "bug traps," as they are called, while Officers of foreign nations have so much better ships. These ships are nothing more than ten-gun brigs lengthened and engines put into them. Now I should like to see any Commander who, on appointment to his first command, were to go up to the First Lord of the Admiralty and say, "I do not think this ship is good enough for me. It is not so good as a French ship." I should like to see the man to do that, for I believe as long as you laid three planks together and rigged up a boat-hook staff to put a flag on, you would always find a naval Officer ready to take command. That is about all I have to say, except that I agree with what Sir John Hay said about the comparison between the French and the English ships, that we should not look upon the building of French ships as a direct menace to England. I do not believe it to be any menace to us. France as a Continental Power must build ships to be on a match with Germany and Italy. She must look out for herself, and our business is to look out for ourselves. If we do not do so, we are a nation of fools, and are proving ourselves to be unworthy of the great heritage of empire which has been handed down to us by our forefathers.

Admiral J. C. WILSON: Having lately come from the Channel Fleet I think I may say the subject of Sir Edward Reed's paper has been universally talked about for many years past. At sea the ordinary conversation has been about the inadequacy of the Navy for the work we may have to do. If our Navy is to succeed and to protect our Colonies and our trade, it is absolutely necessary when war is declared that we should be in a position to take the initiative. That has been very clearly put by Captain Colomb and others; it is absolutely necessary to protect our trade that we should be in a position within a fortnight to put our squadrons to sea, and by sealing up the enemy in his different ports prevent his getting out and destroying our commerce and trade, and unless we are able to do so, we must be placed in a very bad position. The proper estimate of the strength of our Fleet is the number of ships which we can man, equip, and send to sea, say, within a fortnight's time. It is no use talking about ships on the stocks, and it is no use talking about men in reserve, unless we can put our hands upon them. I will not attempt to go into technical questions, because we are the men to sail the ships and not the men to build them; but still we know something about the machines we live in, and I must own I am one of those who like a bit of armour all round the water-line, I do not like these soft ends at all; they may not be breached as the Admiral said just now like a fortification, and have a big hole knocked into their deck big enough to drive a coach and four through, but if one or two shots penetrate, and water gets in, the ship will get down by the nose, she won't steer, she cannot steam, she is thrown out altogether, and you lose confidence in the ship. What is the result? You are at a disadvantage, and you are knocked into a cocked hat. I also agree with my friend Captain Colomb, that we have no type of ship to my fancy equal to the "Dreadnought," or to the good old "Thunderer." Give me the "Thunderer," the hull of the "Thunderer"; she had bad engines, she was not arranged as I should like inside, she was badly gunned, as we know, and she had not enough light guns or sufficient armament; but she carried 1,750 tons of coal, could steam at 10 knots from here to the Cape, and could fight any ship of her class on the salt water. We are all agreed that what we want now is more ships; we do not much care what they are. Captain Fitzgerald exactly expressed the feelings of naval Officers when he said that we never ask what style of ship we are put on board of; we do the best we can with what is given to us. Still if you ask us whether the flag is safe we have our own opinion of which is the best class of vessel. We must not lose sight of the fact that Sir Edward Reed is touching upon only one item of our naval expenditure; he is only speaking of the ships that we require. Beautiful ships of that sort (looking at the plan of the "Esmeralda") we only see on paper; we never have them afloat. When I commanded in Australia I had not a ship out of the whole squadron that in ordinary weather could be trusted to steam at full speed from Sydney to Melbourne—800 miles, and still less to the Colonies lying to windward. There are other things that we must look to; none of our squadrons are completely organized or constituted. What would a military commander think if he were given half a dozen batteries of artillery, and told that he had an army? He would say, "No; I want infantry, I want cavalry; I want fifty other things you have omitted." We have big ships knocking about, but where are our frigates? Where are the eyes of the squadron? Where are our torpedo-boats? Where are our coaling vessels? Where are our electric light vessels? Where are the numerous auxiliaries you require to constitute a squadron? When the squadron is so complete, will it not modify our tactics? Will it not alter the whole of our evolutions? Are we aware what fleet manœuvres we shall have to perform at sea in the face of an enemy with a fleet properly constituted? I say we are not. We have lived on tradition so far in the English Navy—very little else. We have lived on Trafalgar, and just in the same way as the French fleet is organized to the very last gasp, and everything that possibly can be done has been done to bring it to the greatest perfection, because it failed at the beginning of this century, so we have let things lie fallow, very much in the same way as the French Army was allowed to lie on its laurels until the North German Army overwhelmed it. Why do not members of Parliament go down to listen to Naval Estimates? Because they believe the English Navy is invulnerable, and that because it beat at Trafalgar it must always conquer. We will do our best when we are

sent to sea, but we cannot make bricks without straw. This question of money also touches the internal economy of our ships. Very nearly half the crews of some of them are non-combatants. What would have been our case in real war if after the bombardment of Alexandria the Admiral had had to send on shore his landing parties? His ships would have been left with probably less that 50 fighting men on board. Why is this? Do you think that the Admiralty does not understand it? Certainly they do, but we have no barracks to train our men in, and they cannot be trained afloat; it means money, which is not provided. Touching transports, it is advisable to keep ours going, because they employ a portion of the men due to the standing Navy, and if we employed merchant transports, these men would be thrown on shore and would not receive the training at sea which it is so advisable that they should have. I have one more word to say. The public think that we Officers in the Navy are alarmists, and the consequence has been that we have gradually given up speaking at all. I did not come to speak to-night, but the spirit moved me and I could not help it. I think it would be well that the public should understand that we as naval Officers gain nothing by the expanding of the Navy; the advantage in no way goes into our pockets; what we wish to see is our profession put on a proper footing, and that we, wherever we sail and wherever we go, should be able to maintain the honour of the country and of the flag under which we serve.

Mr. Arnold Foster: I think, Sir, that the most urgent measure of all that should be taken for increasing Her Majesty's Navy has not received the attention which might well have been accorded to it. The fact is, before we increase the Navy it is perfectly obvious that we must get the money to do so, and in order to get the money we must convince people by arguments appealing to the common understanding, that it is wanted. I cannot help regretting that Sir E. Reed has put those figures upon the wall to-day, for though we who are here know very well, as indeed the lecturer has been careful to explain, that they are his minimum estimate, that they do not include any estimate for guns and fortifications, and that even for their professed purpose they ought to be largely supplemented by an additional estimate in the future, that is not what will be appreciated by the public outside, and the public will be only too ready to believe, as undoubtedly they will be told, that the sum there stated is considered to be a sufficient estimate by a person of Sir E. Reed's eminence. The popular feeling is so strong at the present moment that I believe we should do very much better by stating something nearer the maximum figure which we require. There is no reason for overstating it, but I do think we ought to get very much nearer the maximum than the figure given by Sir E. Reed, because though it is perfectly true at the present moment that the more you increase the sum you ask for the greater will be your difficulty in getting it, this is not a state of things which need necessarily last, and it will only last as long as the outside public do not appreciate the nature of the problem to be dealt with. I confess I do not think that naval Officers have done quite all they might to convince the outside public as to what is the real danger which threatens them. I think more might be done to demonstrate what is the nature of maritime war now-a-days, and what it will really mean. I see two names on that list of French ships which in their English equivalents show what to my mind war will be—it will be "terrible" and it will be "devastation." Now I do not think the people of this country quite know what war would mean. They knew what it meant to some extent at the beginning of this century, when ancestors of my own friends on the South Coast had orders to destroy their property and retreat on London on the alarm being given of the French landing. The bulk of the people now do not know what war means, and though there have been references made here and there during the course of this discussion to what would be the condition of Edinburgh, of Liverpool, and of Brighton, if war were declared, the English people at large do not realize what must occur. I have a great respect for the French, but I believe that if they make war they will not make it with kid gloves on. I do not think we appreciate what a real naval war would mean for this country, and I think a little more detail should be put before the public as to what has actually taken place in naval engagements in recent years, and as to the suddenness of naval movements, they should be made to

realize the importance of Colonel Maurice's statement that nine wars out of ten come like a bolt out of the blue, without any declaration of war at all. If these facts were brought out they would awaken the public to a true sense of the danger. I am quite certain, knowing as I do something of the way in which people look at these things outside professional circles, that unless we confine ourselves to the very broad facts of the situation, we shall not get people to realize the truths that we want. Now I think that may be best done in this way. I have gone very carefully indeed through the condition of every foreign station that we possess, and have seen what force we have got there, and I want naval Officers to tell the public with regard to those stations, not what we can do, but what we cannot do—what are the certain things which to-morrow or in three weeks' time we could not do. People talk as if these were arguable matters, as if it were an open question whether such and such a place was defended or not; but they are not arguable matters; that list on the wall is to a certain extent a fancy list, even that short list, and people want to be told that such is the condition of affairs that within three months from this time we could not put a reasonable and adequate squadron on any single station which we have to defend. Broad assertions want to be made—must be put I was going to say—in the most offensive, but at any rate in the most aggressive manner, and it should be left to those in authority, if they can, to contradict them, because that is the only way in which you will get the people of England to change the state of mind in which Sir E. Reed says they now are, a state of mind in which they will refuse any proposed increase of money adequate to the needs of the situation. What they ought to be made to understand is that they are simply paying for their safety from day to day, and that they are in great danger at the present time; this conviction we can only drive into their heads by the very broadest and plainest statements.

Colonel Sir CHARLES NUGENT: I think, Sir, that perhaps the taking part in a discussion of this kind by an outsider may do something to relieve it, in the eyes of the public, from the appearance of being merely a professional agitation, and therefore, with your permission, I will say one or two words. I have taken a good deal of interest in the subject, and have studied very deeply the defences of the Empire, basing that defence on what I believe must always be its foundation and corner stone—the strength of the Navy. I do not propose to enter upon any discussion as to the merits of different classes of vessels; it is evident there is a great deal of difference of opinion on that point, and I may also for the moment say it is unwise, as I heard a gentleman here to-day remark, to take foreign estimates of the power of the British Navy. We can estimate the power of our own Navy, and may estimate well enough for our own purposes the strength and powers of foreign Navies. When I look at what Sir E. Reed has put before us, bearing in mind the extent of water communication as well as the extent of commerce to be defended, I must say I do not think he has put down nearly enough. I find in looking at that that he proposes to add eight armoured cruizers, one, I think he said, for every station. If I may venture to say so, that is by no means enough. Indeed I would observe with regard to it that it is putting all your eggs in one basket in each station. Now with regard to torpedo-catchers, Sir E. Reed proposes to arm them with one good gun. I think it is quite right that they should be made independent; but I would go further than Sir E. Reed, and I do not think, however good a 6-pr. Nordenfelt or Hotchkiss gun may be, that it is the gun for these vessels; they ought to be armed with a better gun; and then, reverting to the all-your-eggs-in-one-basket principle, you ought not to be content with one gun per vessel. I am very glad to see Sir E. Reed proposes a plan, which bears a great deal of merit on the face of it, for resisting torpedoes. I have been concerned a good deal with experiments of late years, and although it is very necessary to make experiments, yet still in many a case you can see from the design itself that even it promises a fair chance of success, and in my opinion it is very often advisable not to delay because experiments necessarily take a very long time. So it may perhaps be not advisable to delay construction of ships waiting for experiment only. There was one observation which fell from Sir John Hay which was of a very alarming character; he said the number of guns required by the Navy was 2,900, whilst the guns available were only 387. This no doubt is due in great

measure to the transitional state of gun manufacture. It is not fair to put this altogether either on the Admiralty or the War Department. I believe the same state of things, happily for us, more or less prevails in all foreign countries, or if not, at least in that particular country with which we are most concerned. I cannot, however, say that we have passed out of this transitional state in gun manufacture as quickly as we should have done. It is now many months, I might almost reckon the time by years, since the Ordnance Select Committee, who dealt with this, did distinctly recommend both with regard to the material and to the system of construction for heavy guns; the delay that has taken place, however, is not after all due to the particular department which deals with guns, but is due to the department being ruled and over-ridden by civil officials, who view the state of the case from a Chancellor of the Exchequerish and financial point of view merely. I will only say this, that I thoroughly agree that the Navy is by no means what it should be, because after all Sir E. Reed has proposed, I see no fleet for home defence, and that appears to me, as a man intent upon the defence of the country, to be a most vital point,—it is like arming a man and leaving out the armour over his heart. Therefore I should like to see Sir E. Reed's estimate corrected by doubling the number of armoured and of unarmoured fast cruizers.

Admiral GORE JONES: I think the main subject has been thoroughly thrashed out, and after the excellent address of Sir Edward Reed there is little more to say on the matter of ships, but I would beg to point out that the object of the meeting is to determine what will conduce to the more efficient state of the Navy, and it seems to me the chief point has not been touched upon at all, the necessity of dry dock accommodation, especially in the East Indies and the Pacific. Everybody agrees that speed is the great modern requisite, and we combine the skill of the designer, builder, and engineer to obtain it, and as Sir Edward Reed observed even an extra quarter of a knot was a great matter, but for want of docks, we are unable to retain speed after we have got it, or to effect repairs. I have known a troop-ship start from Bombay minus one fan and lose two others before she got to Malta, and I have seen my flag-ship decrease in speed from 16 to 13 knots in about six months from foulness of bottom. Now doubtless public opinion will cause a sum of money to be voted for naval purposes, and I hope the dock question will be considered, as it is really of more consequence to the efficiency of the Service than a ship or two more or less.

The CHAIRMAN: We are close upon the time for closing the discussion, but Commander May is present, and as he represents the junior branch of the Service, it will be desirable to hear him.

Commander MAY: Admiral Boys has kindly said that he would like to hear a few words from the junior branch of the Service, and I will say but very few words. I think that four words are all I really need to say for myself and my junior brother Officers. We want to learn. We want to learn tactics; we want to learn torpedo warfare. Where can we do it? There is no school of tactics as far as I know, and there is no school of torpedo warfare. I was serving a short time ago on the Mediterranean station. A first-class torpedo boat was at Malta, and she was to go out, and there was some little excitement among naval men there. Who was to take her out? Nobody had been in a first-class torpedo-boat before. How was she managed? They did their best, and I hope it came right in the end. Still, that is not, I think, the way to fight those torpedo-catchers, and these auxiliary craft. We want to learn how to fight these new ships, and I think we should have some method of doing it. Then with regard to our coaling stations abroad, they must be protected, and who is to protect them? You see there now, perhaps, a torpedo-boat, and perhaps a few guns. Who is to work them? Should not the former be entrusted to the Navy, and would they not if kept in commission give some employment to the men and Officers who are often unemployed for some time and learn nothing, and perhaps in the case of the men unlearn what they did know. We young Officers, I am sure, owe a great deal to this Institution for teaching us, but we do want some Government help, and that means money in some school for teaching us systematically. Then as regards information, at present I happen to hold an appointment where a great deal of confidential information is open to me. We naval Officers are asked our opinion about armoured belts and other things, but we have very

little information as to what guns will do, what they have done, or what they may be expected to do, because our information, if that in the War Office is shut up, is confined to what we can obtain from foreign countries. I do hope some steps will be taken to disseminate information among us. Then with regard to experiments; cannot the Navy conduct some experiments of their own without having to go to the War Office, or to those irresponsible people who keep the money bags? That is all I have got to say.

The CHAIRMAN: Gentlemen, as it has struck 5 I think the time has arrived when we should ask Sir Edward Reed to answer the various observations that have been made. For my own part I entirely concur in the details that Sir Edward Reed has given us as to the scheme he has laid down, so far as it goes. I think his classification exceedingly good, and his reasons for it are very sound, but I do say that what is wanted is a definite and authoritative statement of the whole, entire, and complete requirements of the Navy, in order to enable it to protect our commerce and defeat our enemies in case of war. I think there is considerable danger if it goes forth that the plan of Sir Edward Reed, which he in his lecture has taken care to announce is not a complete plan but only according to the text of his subject "most urgent," is at all adopted as a whole and, considering the usual course of events, I think it is as certain as anything can be humanly speaking, that it will be adopted as a whole, and that it very likely will have to go through those curtailments which every estimate has to go through before it is acted upon. That is the great danger; but I hope still that we shall get a full and complete estimate and scheme of what is required for the entire purpose of renovating, and for replacing the Navy in a position to be able to deal with our enemies and defend our commerce. As regards ironclad ships Sir Edward Reed has very clearly shown the fallacy of supposing that we ought to derive any satisfaction from the fact that the French are replacing their obsolete wooden ironclads by the most powerful ironclads because the wood has decayed. We also have a number of obsolete ironclads which are doing duty at this moment, in fact the Channel Fleet is usually composed of them. Those ironclads are as unfit to stand up against modern ironclads as if they were made of brown paper. I think all those obsolete ironclads should depart altogether from our lists of ships to which the honour of the country is to be confided in fleet action, and they all ought to be replaced by ironclads of the very strongest and most powerful description. There are a few of those to which I will refer in a moment, but I will go on to say that I think it is a sure and sound basis to go upon in fixing our number of fleet battle-ships if we take care, as far as we can, to aim at never sending a fleet into action that is not superior to that of the enemy. At Trafalgar we could afford to go into action with an inferior fleet, but now when we are going to depend upon penetration of shot fired by machinery and other things, it is absolutely necessary that we should return to the sound military principle of meeting our enemy with a superior force at the point at which we are going to fight him. To do that we should not have the delusion that that amount of superior force is all we want. In the first place, Sir Edward Reed has very clearly shown that upon the whole our ironclads are inferior to the French ironclads in power, taking the averages of them. The most powerful ironclads we are short in; in the weaker ones we are strong, therefore the average is less than that of the French, and that is the reason why we should have a larger proportion. Secondly, as it will very generally be the business of our fleets to keep to sea, and that of our enemies' fleets to remain in harbour, there is a very large proportion wanted in order that we may have the normal superiority in ships by replacing those that have been subjected to the usual vicissitudes of ships that keep to sea. I am speaking of our ironclad fleets for battle, and I think any responsible Minister or person who thought that our battle fleets should be less than half as much again as any probable combination that might be formed against us in war, would be a rash and imprudent man. I entirely agree with Sir Edward Reed that the powerful armoured cruizers that he proposes should not be attached to fleets, but should be detached to foreign stations and in foreign seas; but I think that amongst the obsolete ironclads, many of whom would do good service as local defences for our own coasts, and perhaps in our Colonies and coaling stations, there are six, the

"Warrior," the "Black Prince," the "Achilles," the "Agincourt," the "Minotaur," and the "Northumberland," that are ships of great capacity, built I believe on fine lines, and though too little armoured to be at all capable of entering into fleet-battles of the present day, are eminently fitted, not to come up to Sir Edward Reed's idea of armoured cruizers to go 18 or 20 knots, though with their present equipment they go 14 knots, although I would go to considerable expense to give those ships the newest description of engines, combining lightness with power, that modern mechanical ingenuity has devised. I would give them a lighter armament, modify their armour, and give them a rig which would develop their sailing capacities as far as possible. In that case I think those ships would be a very valuable addition to Sir Edward Reed's five, which is no doubt an instalment. With reference to the home defences of this country, I think we should be very much subjected in cases of war to minor descents and raids upon our coast for the purpose of harassing the country rather than to make a permanent lodgment, and to prevent that I believe the cheapest and best way would be to have a large number of the torpedo-boats of which we have now a few. But if so it is desirable that they should be provided in time of peace. We have not only to provide them, which can be rapidly done, but from their peculiar method of warfare they require that people should be trained to use them. In Sir Edward Reed's paper he has here and there, so to speak, broken away from the technicalities of his subject, and has made observations which strike me as being particularly wise and statesmanlike. I will notice one of them—I think it has been referred to before. I shall not take up your time by reading it at length. He says, in the last sentence, "We have at the present moment a Government that strenuously deprecates war and endeavours to avoid war everywhere, but it is not on that account able to keep the country out of war or to avert the sending forth of numerous armed expeditions: a policy of peace in Europe to be effective, must, with us, ever be associated with ample naval power." I think the converse of that and of the whole of that paragraph is also true—that there is no guarantee for the peace of the world and for the highest interests of civilization so sure as a powerful English Navy. With these few observations I will ask Sir Edward Reed to reply.

Sir Edward Reed: Mr. Chairman, Gentlemen: When the Council did me the honour of inviting me to read a paper, and selected the title of it, I thought it was my duty not to take advantage of their kindness and attempt to express my views upon the whole question of naval enlargement and naval policy. I thought that the Council would be entitled to consider that I was rather taking a mean advantage of them if I attempted to set myself up as an authority upon the largest view and aspect of this naval question. I do not know that my modesty would go the length of denying me the privilege of holding views on that question, and under some imaginable circumstances, of expressing them; but the problem put before me was a limited one, and I thought it my duty to the Council to strictly abide by it and keep within its limits. Much has been said about the inadequacy of the proposals that I have made. Well, they provide for an extra expenditure of 6,350,000*l.* upon ships and torpedo-boats only; and that is not the whole cost, by any means, of all the ships which I propose to add to the Navy, because, as it is easy to see from the first item, a very large amount of further expenditure must be made upon the armoured ships in the Royal Dockyards before they can be brought to completion. I have not worked out the figures, but I should think the whole proposal involves an addition of 8,000,000*l.* worth of finished ships to the Naval Service. I have stated in the frankest manner in the paper that I can only regard that as an expenditure suggested by the title of the paper, which is not "What are the measures that should be taken for bringing Her Majesty's Naval Service into a satisfactory state?" If that had been my subject I should have been open to much reproach for not having dealt with many questions that I have entirely avoided. But the title was "What are the most urgent measures that should be taken for increasing Her Majesty's Navy?" Now I thought that really pointed to an increase in the number of ships, and I confined myself to that subject. I made a moderate proposal—I admit, at each point, an inadequate proposal—but I made it for the reason which was indicated somewhat by Mr. Arnold Foster's remarks, although his observations took another form. I made it for this reason, that if you allow the country to think that the present excitement is merely an

outcry of naval Officers to have the Navy improved, from professional pride or sentiment, or that it is a movement on the part of naval architects to see more ships built, or, still more dangerous, that it is a movement on the part of contractors for ships to get orders from the public purse, then your movement will come to nothing. What you have to convince the public of is that the movement is a very earnest one, and that the means advocated by persons who devote themselves to the study of it are honestly recommended, and recommended under a sense of very considerable responsibility. That is the object I set before myself, and I am very glad to know that at the end of this debate I can look back upon no observation of any gentleman which has thrown any sort of doubt upon the moderation of the proposals I have ventured to suggest. There have been some questions that have taken a shape in the debate different from that which they took in my paper, and I cannot help thinking that it is in some degree to be regretted that in the debate they did take that shape. Now I hope those present will bear in mind that my only reason for estimating the armoured tonnage of our ships in the manner in which I have estimated them, was for the purpose of leading us to a conclusion as to how much armoured tonnage we had got, and how much we wanted. I never raised the question in the paper at all, I distinctly refused to raise it, as to whether ships with citadels limited to one-third of their length are good fighting ships or not. I have left that to the responsibility of the Naval Service, on which, however much Officers may endeavour to escape it, it rests heavily, for my opinion is, that if naval Officers had expressed in a public manner the sentiments which have been expressed to me in private over and over again, such a Navy for this country in contrast with such a Navy as that in France would have been an absolute impossibility. Only yesterday in this room a gentleman came to me and said, "I am a naval Officer; there is one passage in your paper which should be taken out of it, for you imply in it an approval on the part of the Navy of the citadel ships; I deny that thirteen out of fourteen Officers are not entirely against those ships, and they feel that they have been imposed upon the Service against the feeling of the profession." I have not myself raised the question of the character or capabilities of those ships. Others have done it, but I will not avail myself of the opportunity of enlarging upon that question much. Still, I will say this, that it does seem to me on this point a fundamental principle that a ship called an armoured ship, and reckoned as one in the Navy of England, and put before Parliament and the country as an armoured ship, should have armour enough to keep her always upright under the fire which falls upon her unarmoured parts, and the question is, how many of those ships have the power of standing upright under the infliction of wounds which never fall on the armour at all? If you never fire a shot at the armoured part, but fire all at the unarmoured part, how many of those ships will turn bottom upwards? I think if a ship is to be called armoured, she ought at any rate to have her vitality protected. I should not have said that much in this discussion if it had not been that the question has been raised outside of my paper. It has been said with great truth by three or four gentlemen that my paper is defective in saying nothing about coast defence vessels. That is perfectly true, although it was my business to suggest additions to Her Majesty's Navy. But the reason was—it may not be a justifiable or a defensible one, but perhaps it will be accepted by the meeting—that I find myself reluctant, with a Navy weak as ours is for the great purposes of the State upon the sea, to turn my thoughts at all to coast defence. Of course I know that the coast defence is made immeasurably more necessary by our weakness on the sea, but still I cannot bring myself to be the advocate of a coast defence vessel or of a series of coast defence vessels at the expense of the sea-going Navy. Therefore it was that in recommending, as I was desired by the Council to do, the "most urgent measures" that should be taken, I gave not only precedence, but exclusiveness, if I may so phrase it, to the recommendations about the sea-going Navy of the country. I was very pleased with the speech of Sir George Elliot, with which the debate opened. I thought it was well worthy of the occasion. It was in the highest degree moderate and sensible, and it gratified me inasmuch as Sir George Elliot, although he had not then listened to the wise suggestion of Sir Spencer Robinson not to expend our influence at this meeting on detailed discussions of ships, yet has, as we all know, taken a deal of pains and many public steps with regard to the defence of

ships from torpedoes; and when he looked at my plan for defence against torpedoes, he considered it with the greatest possible readiness, and only desired that the best thing should be adopted. I only brought that into my paper to show that I for one was not prepared to believe that we might not have considerable defence against torpedoes. Many observations have been made upon the quality of the armoured vessels, and some things have been said which I do not quite agree with, but really this debate has been so valuable, and in the main has turned upon such large issues, that I do not feel disposed to refer to these minor matters from which I dissent. Therefore I shall leave some of the remarks of Captain Noel and of Captain Orde-Browne out of consideration; but there was one thing that Captain Noel said that I thought of considerable importance, and which has weighed very much with me at times. It was to this effect: that while in the unarmoured ends of ships, and through the sides of unarmoured vessels, all shot and shell that is worth thinking of or talking about must enter, a large proportion of the shot and shell that strike against ships moderately armoured will be completely turned aside, and, therefore, the unarmoured ship accepts all the mischief that the enemy offers her, but the armoured ship rejects the greater part of it. I consider that to be an immense advantage. Mr. White, I think, in a very fair speech, made such pointed reference to the Italian vessels, and used the reference for such a purpose, that I am obliged to say a word or two about them. Mr. White will forgive me for saying that he somewhat misconstrued and somewhat perverted this reference of mine to the Italian armoured ships, because I have not attempted to give to this Institution any measure of the fighting power of the British Navy. I have observed that when this great question has been discussed in the country all official persons, and Sir Thomas Brassey pre-eminently, have put the tonnage of these fully-armoured French ships on one side, and the whole tonnage of those one-third armoured English ships on the other side, and I came here to say in the presence of the officials and influential gentlemen assembled in this place, that on that point I think Sir Thomas Brassey was doing a delusive and dangerous thing, and I believe that it is wholly wrong to compare the whole tonnage displacement of a ship that is partially armoured with the whole tonnage displacement of a wholly armoured ship. I think it was Captain Orde-Browne or Captain Noel who said it would be more fair to take the weight of armour that a ship carried. But that would never do, because supposing you take one of these ships as our own and take 50 feet of armour off each side, you would have very little but bulkhead left, and what earthly use would the bulkhead be? It is not wise to exaggerate our own strength in a matter in respect to which we may be sadly deceived in battle. I think the wisest way is to reckon armoured tonnage as that which is protected by armour, and let the other go. This I will say, if an armoured ship were put between a couple of unarmoured ships to buoy her up, you would never reckon their unarmoured tonnage in the armoured tonnage of the country. I have no predilection at all: all I say is if a man with his eyes open, and with his attention drawn to the fact, chooses to persuade himself that any one of these ships has the same armoured tonnage as one of the others, I am sorry for him, and I am sorry that he should be going about the country doing the very great mischief which I apprehend will be the result. Therefore Mr. White will see that in such a comparison as I have made I have nothing to do with any form of unarmoured ships. The "Duilio" and "Lepanto" are known to be unarmoured ships, the vitality of which is not protected by armour at all, and it is open to the "Esmeralda," or any other ship of that class, to open up the sides of the "Duilio" or "Lepanto" at the water-line and turn them topsy-turvy. They have been denied by the naval authorities of their country the protection of an armoured belt. Neither their stability, nor their speed, nor any of the other qualities which a naval Officer desires to have, at any rate for some time, under his feet during battle, is guaranteed by armour at all. How did this come about? The Italian Government did not originally intend to build such ships; they intended the "Duilio" and the "Dandolo" to be armoured ships, but I visited Spezia and found they were in great difficulties. They had made miscalculations, they were obliged to contract the armour, and the proposal at the time was to put in some boilers outside the armoured part of the vessel. Then having got the ships in that state they had to

defend them and do the best they could with them. Then they took the next step and said, "We will build ships with only patches of armour here and there to protect this and to protect that, but as we know that their floating power is unprotected, we will give them abundant speed to keep well out of the way of all armoured ships." Admiral Boys took a slight exception to my reckoning interest, but I think he did not quite catch my point, which is this, that if you build your ship in three years, and have it in a state of readiness for anything that arises, then your money is completely invested, and you have no charge to put forward for interest, because she now fulfils her object, just as this building, or any other, fulfils its object; but all the time you have her unfinished, when, as Captain Fitzgerald pointed out, she is of no earthly use to the country, you are bound to charge the interest on the money invested which is not brought to the advantage of the country. I was not as much pleased with the speech of Captain Colomb as I expected to be, for he is an Officer for whom I have great respect, and whose abilities have been well known to me for a very long period. In one thing he said he was supported by Admiral Wilson, which of course was very gratifying to me; that was that the last ship I designed for the Admiralty, the "Dreadnought," was highly appreciated. I am sure also that must be very gratifying to my esteemed friend Sir Spencer Robinson, whose battles on behalf of efficiency I was well acquainted with. I am sure he must be very pleased to hear what has been said to-day of the "Thunderer" and "Dreadnought," and I may safely say that if the "Dreadnought" is in any respect superior to the "Thunderer," she would not have been if the original design of the "Devastation" class had not been cut down to meet financial pressure.

Captain COLOMB: I expressed what I thought was the opinion of the Navy, not my opinion.

Sir E. REED: I am very glad you were able to say it was the opinion of the Navy. The point I was going to take exception to was to something that fell from Captain Colomb which rather implied that I had sought to engage the gentlemen present in niceties about ships. There has not been in my paper any discussion of niceties, and having taken great pains to suppress every personal preference and feeling touching the construction of ships, in order that this Institution might have a broad paper based on the highest possible grounds, I rather object to have it said that I introduced niceties. He also said, and that surprised me more, that he thought it was not well to build armoured cruizers, but something that there was more agreement upon. To the armoured cruizer not a single soul has taken exception. During this debate several Officers and gentlemen have mentioned them, but they have all agreed, and the most striking and convincing confirmation of that item of my programme was the words which fell from the Chairman. Nobody has taken any exception to the armoured cruizer, and thankful indeed am I that it is so, because I believe that if you gave them no other armour but that of some ships of 19 knots, just an armoured belt that might not be crippled readily by the shot of armoured vessels, it would be of such immense advantage that I hope Mr. White will urge his renowned firm, of which he is so distinguished a member, to build such vessels. Admiral Jones was kind enough to say we wanted speed.

Admiral GORE JONES: What I said was that all the intelligence is brought to bear on getting the speed, and we do not retain it.

Sir E. REED: I entirely agree with that, and regard it as an important subject; and all I wish to point out is, saying nothing about the first-class armour-clads, that in all my vessels, the five armoured cruizers, the unarmoured, the torpedo-catchers, and torpedo-boats, my whole programme provides for extremely fast vessels. I will not detain this important meeting any longer, except to make one other remark. My attention has been drawn to it to-day. Sir George Elliot said that experiment has shown that a water-cushion is a good thing for the resistance of torpedoes. All I have to say about that is, that so far as my experience and study of experiments with torpedoes go, the torpedo does not make much of accumulation of water. If it has 6 or 8 feet to go through, it takes its full effect at the end of that distance, and a water-cushion is only available when you have got the first violence of the torpedo dealt with in some way or other. I believe the proper way is to stop the torpedo as far as you can from the vital part of the ship in which

the engines and boilers are, and let it expend its force as much as possible before it reaches it. I think I need not say any more, except this, that it never would have occurred to me to propose a paper to this Institution, or indeed to propose any further discussion on this subject. I occupy a position which is one of extreme pain. I believe the political party to which I belong are, as a body and in the bulk, as anxious as the other political party to make the Navy what it ought to be; but unfortunately we have to sit by year after year and find, not the Navy made stronger, but the Navy receiving the very best and most exaggerated and presentable account of it that the responsible Ministers can possibly frame. When I wrote the paper I wrote a sentence which I afterwards struck out, but perhaps I may be allowed now to put it in at the close of the debate. It was to this effect, that I have tried to give not at all a full programme, but an actual and carefully considered programme about which men might gather, and of which they might say, "Give us that at any rate, whatever else we may have to ask for." I have done it to the extent you see, and I have done it at the time when it is almost perilous to speak the truth about these things, and when certainly a man increases his public eminence, the consideration which he receives, and what is worse still, the authority which he becomes, very much more by leading the nation blindfold to the brink of the precipice rather than by incurring the odium of stating the facts which he knows.

The CHAIRMAN: I hardly like to undertake the duty which now falls upon me of addressing the ordinary language which we are accustomed to address to our lecturers to Sir Edward Reed. For he is not an ordinary lecturer. He has come forward at a grave crisis when the country has at last become aware of its immense deficiencies and its danger—a thought which ought to come home to every man, woman, and child in the country—he has come forward with patriotism, and as he has just said, with some degree of pain to himself, in order to ventilate a subject of such vast importance, and not merely we who have been present and have heard the lecture and discussion either wholly or in part, but the whole country ought to feel grateful to him for what he has done. I shall not attempt to say any more on this subject, but I will on your part and on the part of this Institution return our warmest and best thanks to Sir Edward Reed for the very able and important lecture which he has given to this Institution.

NAMES OF MEMBERS who joined the Institution between the 1st October and 31st December, 1884.

LIFE MEMBERS.

Cust, H. E. P., Lieut. R.N.
Agar, E., Lieut. R.E.
Laffan, J. de C., Lieut. R.E.
Blane, C. F., Lieut. R.A.
Belam, H., Lieut. R.N.
Salisbury, Marquis of, K.G., Col. 4th Bn. Bed. Regt.
Christian, A. H., Sub-Lieut. R.N.
Target, A. T., Lieut. R.N.
Roe, C. H., Lieut. R.E.
Smith, W. H., Right Honble., M.P.
Blackall. H. O., Lieut. R.E.
Poore, F. H., Major R.M.A.
Jackson, W. H. M., Lt.-Col. Ret. Pay.

ANNUAL SUBSCRIBERS.

Stuart, R. R. N., Lieut. Punjab Infantry.
Walker, J. T., C.B., Gen. R.E.
Waldron, F., Capt. R.A.
Bourdillon, J. A., Capt. Calcutta Vols.
Adderley, E. W., Major Rl. Fus.
Hill, T. A., Capt. 12th Lancers.
Churchill, A. B. N., Lieut. R.A.
Swithinbank, H. W., Lieut. 11th Huss.
Wimberley, C. I., Lieut. E. Sur. Regt.
Fowler, F. C., Lieut. R.A.
Cranbourne, Visct., Lieut. Herts Yeo.
Lloyd, M. B., Lieut. R.A.
Ryder, W. I., Lieut. Suff. Regt.
MacAdam, W., Lieut. R.E.
Johnstone, J. H. L'E., Lieut. R.E.
Hills, E. H., Lieut. R.E.
Ewart, J. A., C.B., Gen., Col. Gordon Highrs.
Webster, E. W., Lieut. 1st Herts R.V.
Quick, G., Ch. Eng. R.N.
Fanshawe, F. B., Lieut. R.W.K. Regt.
Leetham, A., Lieut. 20th Huss.
Morris, A., Lieut. 20th Huss.
Garbett, H. J. G., Comr. R.N.
D'Arcy-Irvine, St. G. C., C.B., Capt. R.N.
Bradford, E. F., Lieut. R.N.
Roberts, A. E. S., Capt. H.P.
Moore, C. H. H., Lieut. R.N.
Wray, J. C., Lieut. R.A.
Robinson, C. N., Capt. R.N.
Burne, G. H. P., Lieut. Leic. Regt.
Semini, V., Lieut. Leic. Regt.
Stewart-Savile, W. S., Lieut. Leic. Regt.
Simpson, C. R., Capt. Linc. Regt.
Lawrence, R. C. B., Maj. 1st Drag. Gds.
Drinkwater, G., Capt. 14th Middx. R.V.
Boyle, E. B., Lieut. R.N.
Maunsell, F. G., Lieut. R.A.
Rolleston, J. P., Lieut. R.N.
Bagnall, G., late Capt. Waterf. A. Mil.
Farrer, F., Capt. Ret. Pay.
Stuart, A. R., Lieut. R.A.

OCCASIONAL PAPERS.

This portion of the Number is reserved for Articles, either Original or Compiled, on Professional Subjects connected with Foreign Naval and Military matters; also for Notices of Professional Books, either Foreign or English.

It is requested that communications or books for review may be addressed to Colonel Lonsdale Hale, at the Royal United Service Institution, Whitehall Yard, London, S.W.

THE ORGANIZATION OF THE ELECTRIC TELEGRAPH IN GERMANY FOR WAR PURPOSES.

(*Continued from No. CXXVI.*)

SUMMARY OF THE WORK DONE BY THE GERMAN TELEGRAPHS IN THE FRANCO-GERMAN WAR, ILLUSTRATING THEIR ORGANIZATION AT THE TIME.

REFERENCE has constantly been made to the work done by the German Telegraphs in the war of 1870–71, in the work "The Organization of the Electric Telegraph in Germany for War Purposes," and it appears therefore desirable to give a general sketch of the whole work done by the telegraph in that campaign.

In Part II of the official account of the war by the General Staff, under the heading of "Military Telegraphs," a description is given of the Field and Etappen Telegraph Detachments, but the State Telegraphs are only casually referred to, as the *employés* of this branch were not looked upon as forming part of the *mobilized* Army. But to really understand the work done by the telegraph as a whole, the State Telegraphs must be considered with the other branches, the more so, indeed, as it forms the basis of our military telegraph system.

The description given in the work of the General Staff leaves little to be desired, so far as a clear general description is concerned, and the author, especially as he has not now at his disposal the original reports of the Officers commanding Detachments, and a good deal has escaped his memory since the war, cannot do better than quote the work in question on certain points word for word.

Generally speaking, the three branches worked in accordance with the "Instructions for the Communications of the Army in the Field." The Director-General of Telegraphs, Major-General von Chauvin, had, in accordance with these, charge of the whole *personnel* as well as *matériel* of the State Telegraphs, and was represented on the Headquarter Staff by the Chief of the Military Telegraphs, Colonel Meydam, with whom he was in constant telegraphic communication, and who kept him continually informed of the work done by the Telegraph Detachments, of the demands for stores, *employés*, &c., and of so much of the telegraph requirements of the Quartermaster-General as appeared necessary. As a rule the Director-General remained at Berlin, the centre of telegraphic communication and the seat of the Ministers of War and the Interior, whence he could send instructions in any direction, and act in immediate concert with the Home Government.

Now and then consultations with Colonel Meydam were for many reasons desirable, and with this object the Director-General either paid a visit to the Commander-in-Chief's Headquarters, or to other places in the theatre of war, where questions of telegraphic organization, the establishment of junctions of many lines, or of Military Telegraph Directions, and other such like important matters had to be considered, settled, or tested.

The Chief of the Military Telegraphs had special charge of the telegraphs of the Commander-in-Chief's Headquarters and of the Etappen, but he was nevertheless in constant communication with the Field Telegraph Detachments, though these were under the Generals commanding Armies. His position was thus defined:—"He gave his orders or instructions through the Quartermaster-General, Lieutenant-General von Podbielski, whose special care it was to see to the communications between the Armies, both as regards each other and the Commander-in-Chief's Headquarters. In other matters the Telegraph Detachments were at the disposal of their respective Generals."

The four[1] Field Telegraph and three Etappen Telegraph Detachments were mobilized with the Army, and thenceforward belonged to it; the formation of three Field Telegraph and two Etappen Telegraph Detachments was ordered immediately after the mobilization of the Commander-in-Chief's Headquarters.

The following Table shows the distribution of the various Telegraph Detachments during the war:—

[1] Five, according to the Official Account of the war, but this is wrong.

I. TABLE SHOWING THE DISTRIBUTION OF THE VARIOUS FIELD AND ETAPPEN DETACHMENTS DURING THE WAR OF 1870–71.

A. *Field Telegraph Detachments.*

No. of Detachment.	When formed.	Attached to—	Officers.		
			In command.	First Engineer Officer.	Second Engineer Officer.
1st	On the 16th July, 1870.	The Ist Army	Captain May. From the beginning of September First-Lieut. Witte.	.....	Second-Lieut. Paasche, Reserve Officer in the Engineer Battalion of the Guard.
2nd	Ditto.	The IInd Army. After the 29th August, 1870, to the Army of the Meuse.	Captain Herrfahrdt. After the end of May, 1871, First-Lieut. Degener.	.....	Second-Lieut. Lichtenfels of the 2nd Battalion, 27th Landwehr Regiment (2nd Magdeburg)
3rd	Ditto.	The IIIrd Army.....	Captain Kauffmann. From the 2nd December, 1870, First-Lt. Fischer. From the middle of May, 1871, First-Lieut. Klauer.	First-Lieut. Witte. From the beginning of November, 1870, to the middle of May, 1871, First-Lieut. Klauer.	From the end of May, 1871, Second-Lt. Bauer of the Reserve of the 8th (Rhine) Engineer Battalion.
4th	Ditto.	Commander - in - Chief's Headquarters.	First-Lieut. (from the beginning of October, 1870, Capt.) Friedheim.	First-Lieut. Jaekel to the beginning of December, 1870.	From the beginning of December, 1870, Second-Lieut. Mieck of the 40th Reserve Landwehr Battalion (Cologne).

No. of Detachment.	When formed.	Attached to—	Officers.		
			In command.	First Engineer Officer.	Second Engineer Officer.
5th	On the 14th August, 1870.	The IInd Army.....	Captain Lüdecke	Second- (from October, 1870, First-) Lieut. Degener, to the end of May, 1871.	Vice Sergeant-Major (from October, 1870, Second-Lieut.) Bischof of the Reserve of the 3rd (Brandenburg) Engineer Battalion.
6th	On the 11th September, 1870.	The IIIrd Army. After the end of November, 1870, to the 13th Army Corps.	Captain Bliesener. From the middle of December, 1870, First-Lieut. Flek.	First-Lieut. Flek, to the middle of December, 1870.	From the beginning of January, 1871, Second-Lieut. Baron Gans Edler zu Putlitz.
7th	On the 15th September, 1870.	The 13th Army Corps. After the beginning of December, 1870, to the IIIrd Army. After the middle of January, 1871, to the South Army. After the middle of April, 1871, to the IInd Army.	Captain v. Woyna. From the beginning of January to the beginning of February, 1871, First-Lieut. Jaekel.	First-Lt. Fischer. From the beginning of December, 1870, to the beginning of January, 1871, and from the beginning of February, 1871, First-Lieut. Jaekel.	From the middle of February, 1871, Second-Lieut. Steinhauer of the Engineers.

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MAP SHEWING THE LI
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NOTE.—THE LINES, ESTABLISHED BY THE FIELD AND ETAPPEN DETACHM
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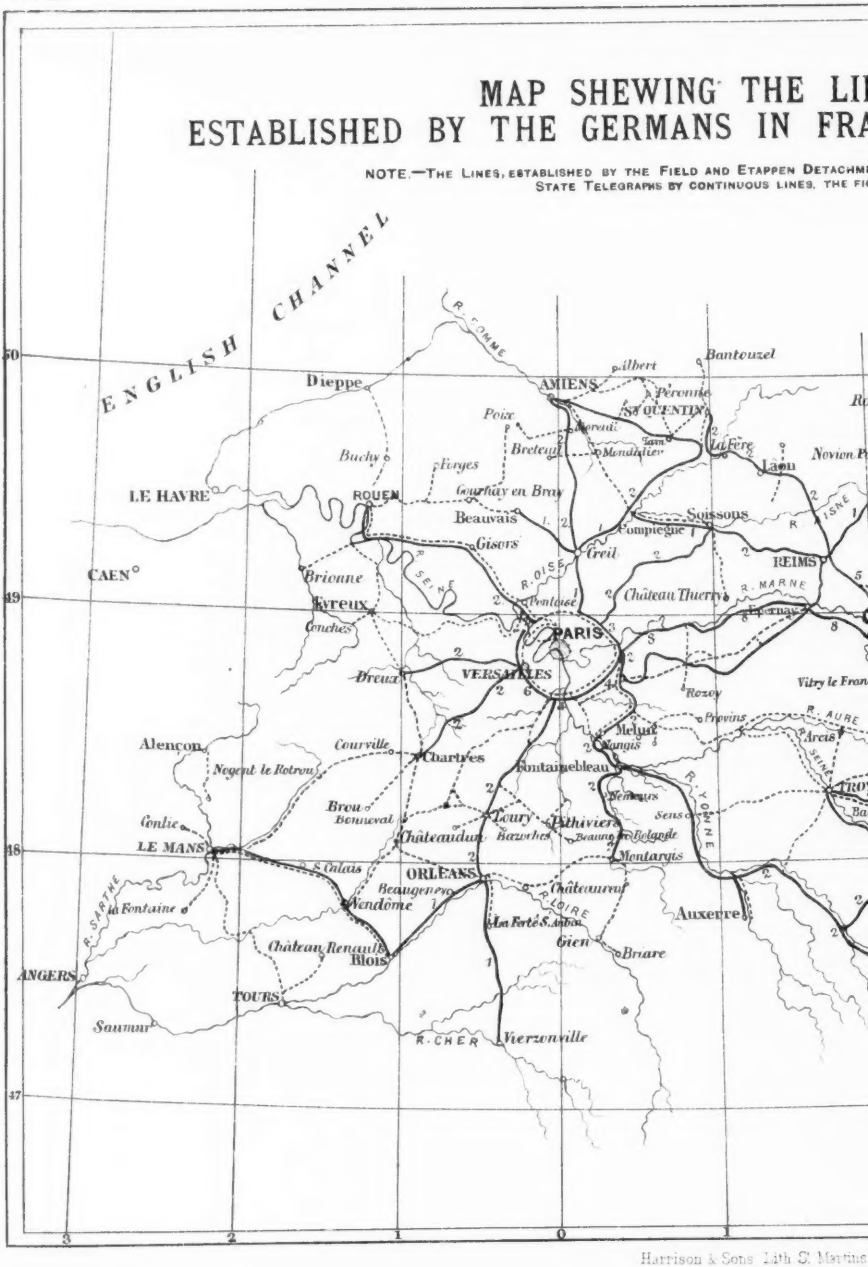

Harrison & Sons Lith St Martins

THE LINES OF TELEGRAPH IN FRANCE IN THE CAMPAIGN OF 1870-71.

ETAPPEN DETACHMENTS ARE SHOWN BY DOTTED LINES, THOSE ESTABLISHED BY THE
UOUS LINES, THE FIGURES INDICATE THE NUMBER OF WIRES

Lith. St. Martins Lane W.C.

B. *Etappen Telegraph Detachments.*

No. of Detachment.	When formed.	Attached to—	Etappen Telegraph Director.	Engineer Officer.
1st	On the 16th July, 1870.	The IIIrd Army.	*Telegraph-Direktions-Rath* Oxford.	Second-Lieut. Uhse.
2nd	Ditto.	The IInd Army.	Ditto von Brabender.	Second- (from the end of December, 1870, First-) Lieut. Micke.
3rd	Ditto.	The Ist Army.	Ditto Seiler	Second- (from the end of December, 1870, First-) Lieut. Diehm.
4th	On the 14th September, 1870.	The Army of the Meuse.	Ditto Massman ...	Second- (from the end of June, 1871, First-) Lieut. Schmidt.
5th	On the 28th September, 1870.	The 14th Army Corps.	Ditto Böhnke	Second- (from the end of December, 1870, First-) Lieut. Volkmann II.

II. Summary of the Military Telegraph Directions created in France during the War of 1870–71.

No. 1. *At Nancy, in August*, 1870.

Director of Telegraphs Ludewig, and the *Telegraphen-Direktions-Räthe* Wohlfahrdt and Cunio; afterwards Director of Telegraphs Post when the Direction was divided into two Inspections, at Nancy and Strasburg, under the *Telegraphen-Direktions-Räthe* von Jahn and Hirsch respectively.

No. 2. *A Provisional Direction at Epernay, afterwards removed to Rheims where it remained till the end of the War.*

At first Director Ludewig with his two *Räthe* abovenamed; next Director of Telegraphs Richter with the *Räthe* Cunio and Scheunemann; and afterwards Director Bothe and *Rath* Cunio.

A Provisional Direction at Lagny, afterwards removed to Versailles where it remained till the End of the War.

During its provisional stay at Lagny the Director was Ludewig, and he, when invalided, was succeeded by Richter, with whom Wohlfahrdt remained, Scheunemann returning to Germany on its transfer to Versailles.

A. Work Done by the State Telegraphs.

After the State Telegraphs had completed the network of telegraph lines in the Rhine Provinces, and the German Armies had crossed the frontier, they followed the latter into the enemy's country, and laid in the course of the campaign, chiefly using the *matériel* of the French State Telegraphs, a

regular system of telegraph lines, practically covering the whole theatre of operations. Director of Telegraphs Ludewig, with the *Räthen* Wohlfarhdt, Ziemann, and Cunio, moved into the Rhenish Palatinate as early as the end of July, and the *employés* of the Cologne Telegraph Direction were at work in French territory immediately after the battle of Spicheren.

In the accompanying map the work done by the State Telegraphs is shown in continuous lines, and that done by the Military Telegraphs in dotted lines. The lines of the latter were of one wire only, whereas the former had in some cases as many as eight wires. The figures denote the number of wires.

The network of lines extended: On the north to Thionville, Longwy, Rocroi, St. Quentin, and Amiens; on the west to Rouen, Dreux, Le Mans, and Blois; and on the south to Vierzon, Auxerre, Auxonne, Baume-les-Dames, Montbeliard, and Delle. The total network may be said to have comprised some 21,500 kilometres of line (exclusive of the lines that were added to the Districts of the "*General Gouvernements*") on which 118 telegraph stations were at work day and night.

Following the lines of operations of the three German invading Armies, those French telegraph lines were chiefly looked forward to which led straight on the one side from the Rhine to Paris, and on the other to Berlin, &c.

Two parallel lines were therefore reckoned on, one from Mayence by Saarbrücken, Metz, Rheims, and Paris, and the other from Strasburg by Nancy, Châlons, and Paris, on account of the number of wires they contained, several of which were for direct international correspondence, and it was hoped that some of them would be found intact, or at any rate in such a state as to be easily repaired. Between Mayence and Saargemünd a third line was chosen, using the poles on the railway between Kaiserslautern and Zweibrücken, and extending by Pottelange and Château-Salins to Nancy, where it joined the main line Nancy—Châlons. A fourth parallel line was next chosen running by Berlin, Cassel, Coblentz, and Trèves, and joining at Perl the French line Thionville—Mézières—Reims—Ternier—Creil—Paris, only unfortunately it passed through five fortified places, and it consequently could not be worked until these places were reduced.

Next, to avoid any stoppage of communication from breaks in the above parallel lines, it became necessary to establish cross lines, and these were first, the line Mayence—Worms—Ludwigshafen—Hagenau—Strasburg, which after the fall of Strasburg became the main line from Alsace to Berlin; secondly, the line from Saarbrücken by Saargemund to Hagenau; and thirdly, the line from Thionville by Metz to Nancy, which was afterwards prolonged by Epinal to Vesoul, and with the line Nancy—Lagny—Versailles, formed the main line of communication between the Commander-in-Chief's Headquarters and the south-eastern theatre of operations. A fourth line joined Reims with Châlons, a fifth Reims with Epernay, and a sixth Creil with Lagny.

Further, in the course of the war the northern parallel line Sierck—Thionville—Mézières—Rheims—La Fère—Creil was established and worked, and again towards the end of the campaign, another parallel line in the south from Mulhouse by Vesoul, Auxonne, Dijon, Montbard, La Roche, and Morel, to Lagny.

From the Commander-in-Chief's Headquarters, as the war progressed, lines were again laid as required, radiating, so to speak, to communicate directly with the various Armies we had in the field opposing the enemy's attempts to relieve Paris. On the north lines were established to Amiens and Rouen; on the west to Dreux, Chartres, and St. Calais; and on the south to Blois, Vierzon, and Montargis.

By establishing the northern parallel lines already referred to, a new and independent through line was obtained with Berlin *viâ* Trèves, and this was of especial advantage, as it enabled Headquarters at Versailles to communi-

cate directly with the captured fortresses in the north, and these again with the War Ministry at Berlin.

By the carefully planned and systematic way in which the State Telegraphs thus went about their work, the Commander-in-Chief's Headquarters were not only enabled from the commencement of the campaign—some rare cases excepted at the very outset—to directly communicate by wire with the Generals commanding the various Armies and Army Corps, but also with every telegraph station at home in the whole of Germany. And as the war progressed and the network of lines became thicker, the chances of interruptions brought about by the enemy's hand and other causes became less and less.

The greater part of the telegrams were sent either directly to or through the central point Berlin, and from Berlin telegrams received from abroad, and having reference to the operations of our Armies in the field, were at once wired to the proper quarter. Thus whilst Gambetta was at Tours, telegrams were sent from that place to London for instance, and their contents thence wired as Belgian or other foreign news, to Berlin. In some cases other large German towns were used to transmit telegrams, but the contents of such telegrams were nevertheless always forwarded to Berlin, where the whole system was centralized.

After the northern line was established, telegrams, unless they were intended for certain places in the theatre of war, passed as a rule from the Commander-in-Chief's Headquarters to Germany by the following lines :—

1. Lagny—Ternier—Reims– Mézières—Thionville—Trèves—Berlin.
2. Lagny—Soissons—Metz—Saarbrücken—Frankfort-on-the-Main—Berlin—Dresden.
3. Lagny—Châlons—Nancy—Strasburg—Karlsruhe—Stuttgart—Munich.

Outside the theatre of war the lines in North Germany were increased with a view to reporting any attempts at landing on our coasts on the part of the French, and enabling General von Falkenstein and the naval authorities in the north to be in more immediate telegraphic communication with the Commander-in-Chief's Headquarters. The additional lines laid for this purpose amounted to 3,191½ kilometres of wire, or 1,320 kilometres of line with 44 telegraph stations permanently employed.

One thing shown to be of the highest importance was a planned network of telegraph lines and an organized system of working, such as could only be produced by long experience and practice in peace. Now as the *employés* of the State Telegraphs simply worked according to the selfsame routine they were accustomed to, and the Instructions of the Military Telegraph Detachments were based on those of the State Telegraphs with only some very slight unimportant modifications in certain details, the whole system worked smoothly and well.

The creation of "Military Telegraph Directions" was a necessary outcome of the system. As soon as a "*General Gouvernement*" was established, one of these was at once formed where it had its seat, and a central station or junction of lines then established, if the nature of the telegraphic communication necessitated it.

The first of these was established in Nancy, the second provisionally at Epernay whence it was afterwards moved to Reims, and the third at Lagny. As soon as the necessary number of wires had been laid between the latter place and Versailles, the "Direction" was transferred to the Commander-in-Chief's Headquarters, but Lagny still remained a most important telegraph station, for it was through here that all telegrams passed from Versailles to the east, south-east, north, and north-east. Had the war continued, a Telegraph Direction would have been established at Amiens, another at Orleans, and another at Chaumont, provision having been already made for this. A fourth Direction was established at Strasburg when that place fell. Thus

the network of German State Telegraphs was actually prolonged right into the very heart of the enemy's country.

The French on their side made considerable use of the telegraph, and had made plans to use it on a large scale at the outset. Thus the General Direction at Berlin heard from London that the French Government had ordered a Hooper's submarine cable, with a view to establishing telegraphic communication between France and their Fleet in the North Sea and Baltic, the idea being to lay a cable between Dunkirk and the west coast of Denmark. Admiral Jachmann, being informed of this, proposed to cut this cable if the movements of the cable ship with the escorting men-of-war were made known to him at the right moment, but the French Fleet being recalled to assist in home defence, the scheme was never carried out. The cable itself was afterwards used by the French to connect Paris with the outlying forts, and one portion of it which was laid in the Seine, was discovered and fished up by our besieging Army.

The number of telegrams delivered in Versailles during the war was close on a million, and many of them were very long. Of the total, four-fifths were taken by the "unmobilized" State *employés*, and the remainder by the "mobilized." From the 20th January to the 25th February, 1871, some 912 were sent daily by the former and 172 by the latter. To further show the amount of work done by the State Telegraphs, the official war despatches compiled by the Headquarter Staff were invariably immediately telegraphed to no less than 1,860 stations on the North German Telegraph Lines to the chief towns in South Germany, and to 37 stations in the theatre of war. Germany, as well as the German forces in France, were thus constantly supplied with the best and most reliable news of the war, and disquieting rumours avoided even among the more ignorant classes.

To take one case in point: the war news received at Berlin was, at the express desire of the Italian Ambassador, forwarded in his name *viâ* Switzerland direct to Turin. The telegrams were translated first into French at the Berlin Central Station. *The news of our brilliant victories of Weissenburg and Wörth probably decided the hesitating policy of Victor Emanuel.*

B. Work done by the Military Telegraph Detachments.

When our Armies first crossed the frontier, the Commander-in-Chief's Headquarters and the Ist and IInd Armies had only the line Saarbrücken—Creuznach, and the IIIrd Army the lines Landau—Ludwigshafen. Beyond these, as the Armies advanced, were the lines of the Field Telegraphs. These ran as follows:—For the Commander-in-Chief's Headquarters and the IInd Army by Remilly to Pont-à-Mousson; for the Ist Army by Boucheporn to Varize; and for the IIIrd Army by Hagenau, Ober-Modern, and Lunéville to Nancy. These were connected by the cross lines St. Avold—Boucheporn, Lützelstein—Saargemünd—Bening, and afterwards Nancy—Pont-à-Mousson. Besides some minor branch lines, a branch was established to connect the Baden Division before Strasburg by Hagenau, Vendenheim, and Steinburg.

During the battles before Metz the telegraph was extended close to the very battle-fields at Courcelles, Gorge, and Thiaucourt. On the investment of the place the Headquarters of Army Corps and Divisions were connected together and with Army Headquarters as well, but owing to a want of stores the outposts had to trust to mounted orderlies and visual signals.

During the advance to Châlons the Commander-in-Chief's Headquarters used the line Nancy—Commercy—Bar-le-Duc, which had been restored by the State Telegraphs; from this the Military Telegraphs established a line to the Army of the Meuse from Commercy to Thiaucourt, and another to the IIIrd Army by Frouard and round Toul to Vaucouleurs.

Just at this phase of the campaign immediate understanding between the

different parts of the invading armies was of the very highest importance, and every muscle and nerve was strained to keep the Army Corps of the IIIrd Army in telegraphic communication with the Headquarters of this Army and the Commander-in-Chief, and the following lines were established :—Void—Ménil-la-Horgne, Vaucouleurs—Gondrecourt, Gondrecourt—Tréveray, Vaucouleurs—Pagny, Ligny—Nançois-le-Petit, Ligny—Tronville, and Bar-le-Duc—Blesme—St. Dizier—Vassy. The telegraph lines next followed the Army in its flank march as far as Varennes and Cernay-en-Dormois, but beyond these places the work had to be taken up by parties of cavalry, as the telegraph stores were entirely expended. It only remains to be pointed out of what immense use another Field and Etappen Detachment would have been when our armies were concentrating round Sedan. Indeed the gap in the telegraphic communication prevented the news of the victory being at once known in Berlin.[1] Immediately after the battle, Sedan was joined by telegraph with the line Clermont—Metz by Montmédy and Consenvoye.

In the march on Paris that followed the battle, the Commander-in-Chief's Headquarters and the Army of the Meuse used the line Nancy—Paris, which was afterwards carried on to Ferrières and Versailles. The Commander-in-Chief's Headquarters were thus in constant communication both with the forces before Metz and Strasburg, as well as with the other parts of the advancing forces. The Army of the Meuse had in the meanwhile joined Laon, after its surrender, with Reims, and on arriving before Paris on the 20th September, had the line Ligny—Noissy—St. Brice in working order. The IIIrd Army, which in its advance established its communication from Epernay by Montmirail to Coulommiers, and beyond this joined the main line at La Ferté-sous-Jouarre, prolonged this line from Coulommiers by Villeneuve St. Georges and Longjumeau to Palaiseau.

During these operations it turned out that the means at the disposal of the Field Detachments were not equal to the occasion, and it was found hopeless to attempt to keep Army Headquarters in constant telegraphic communication with Army Corps Headquarters after every day's march.[2] On the other hand, both Field and Etappen Detachments did everything that was possible in their power to keep Army Headquarters constantly connected with the State Telegraphs in rear.

The Field Telegraph Detachments worked as a rule in the front line, and their stores were replaced by those of the Etappen Detachments. The latter again took down their lines as soon as they could be replaced by the more permanent work of the State Telegraphs.

Our troops, especially at the beginning of the war, constantly completely destroyed the French telegraph lines which were often found only slightly damaged, and to quickly repair them was therefore anything but an easy matter. Even our own wires were often damaged by the troops from sheer carelessness. The parties of engineers, again, that were told off to the Etappen Telegraph Detachments had no practice in restoring lines, and, what is more, were without the necessary *matériel*. Sections No. 2 of the Etappen Telegraph Detachments were alone provided with the necessary stores and appliances for restoring permanent lines, and it was considered their busi-

[1] A private telegram to Count Eulenburg, which reached the central station on the night of the 2nd-3rd of September, announced indeed that the French Emperor was a prisoner, but nobody believed the news, as the name of the sender could not be made out.

[2] Should the number of Field Telegraph Detachments be increased in proportion to the increase that has taken place in our Army since the war, and on the supposition that we may possibly at some future time be engaged in three theatres of war at the same time, such accidents ought never to occur again. For we may safely say that if both Officers and men are properly trained in peace, double the work may be expected of them in our next campaign.

ness alone to repair the enemy's broken lines, for which purpose they were sufficiently provided with well-trained telegraphists, artificers, and stores. Altogether they repaired during the campaign 8,252 kilometres of wire belonging to the French State Telegraphs, and erected 798 kilometres of temporary wire. Things improved with time, but by the end of August it was clearly seen that an increase in the Military Telegraphs was absolutely necessary. Consequently in September two additional Field and two additional Etappen Telegraph Detachments were formed, and these took the field early in October.

To ease the business of the State Telegraphs, which had undertaken the working of the lines between the army in the field and Germany, in the place of the Etappen Telegraphs, and which was rather beyond its powers, three "Telegraph Directions" were established at Nancy, Epernay, and Lagny. Immediately, indeed, the frontier was crossed, the State Telegraphs found difficulties in their way from want of transport to convey *employés* and stores. But, in spite of this, telegraphic communication between the Army and the Telegraphs at home was soon established and kept in working order, with an occasional slight interruption on one or the other parallel lines. In the case of the IIIrd Army, indeed, they may be said to have worked throughout the campaign without a single check.

The Telegraphs were thus in course of time fully able to meet the requirements of their extended field of operations, though the large tract of country over which military operations eventually extended, and the rapid movements of the armies in the field, rendered this anything but an easy task. It often happened that the wires that had been laid with much trouble had to be at once taken down again, the Headquarters of an Army Corps being obliged to alter its destination owing to the contingencies of warfare, and no counter-order on the subject having been received of the fact in time. The line was laid quickest when the Telegraph Detachments accompanied the advanced guards and kept pace with these as they advanced. Very often they even preceded the most advanced troops, accompanied by special covering parties. In such cases it happened more than once that telegraph stations were actually exposed to fire, and sometimes had to retire before the advancing foe.

Bad weather again sometimes was a serious drawback. It not only delayed the work of setting up lines, but sometimes damaged those that were erected. As a case in point, during the siege of Paris it took the 3rd Field Telegraph Detachment 9½ hours in a hard frost on the 4th January, 1871, to lay the Villacoublay—Saclay line, 9 kilometres long, whereas the 2nd Etappen Telegraph Detachment only took 7½ hours in fine weather on the 9th November, 1870, to establish the line Juzanvigny—Brienne le Château—Piney, east of Troyes, 25 kilometres in length.

Finally, there was the wilful damage done to the lines by the inhabitants of the conquered country and bands of armed partizans, and this it was impossible to prevent in spite of every precaution, partly owing to the great length of the lines themselves, and partly to the comparative weakness of the troops occupying the country.

During the siege of Paris Versailles became the centre of the constantly increasing network of telegraph lines. Once the wires which were laid down at the commencement of the investment had gradually taken a form completely encircling the place, two concentric lines were run round it, starting from Versailles and passing by Longjumeau, Villeneuve St. Georges, Lagny, Gonesse, Margency, and St. Germain-en-Laye. One of these lines, to which the lines converging on the capital led, was more especially intended for communication between the Commander-in-Chief, the Generals commanding Armies in the field, and the General Etappen Inspections. The other line, with its many branch wires, was intended for general communication between the many fractions of the investing forces; it not only joined all the various

Army Corps Headquarters with their respective Divisional and Brigade staffs, but also connected certain points of importance in the line of outposts, observatories, and later on, the groups of bombarding batteries.[1]

Two main lines communicated with Germany, one from Lagny by Bar-le-Duc and Nancy to Landau, and the other by Reims and Metz to Saarbrücken.

As soon as the armistice was concluded, the forts were connected with the encircling line and with one another, and when our troops occupied Paris, three stations were pushed forward into the very city itself.

The German armies in the field covering the force blockading Paris were eventually in the course of the war put in communication with Versailles by lines established to Amiens, Rouen, Dreux, Chartres, Orleans, Montargis, by Melun and Montbard to Dijon, and by Troyes to Chaumont-en-Bassigny. To these lines were joined the lines of the various Armies and detached forces fighting in the provinces.

When, after the fall of Metz, the Ist Army advanced towards the Oise, the Field Telegraphs established its communications, using the line already in use, by Reims and Soissons. Before the battle of Amiens the wings of the Army were put into communication by wires from the terminal station Montdidier to Breteuil and Moreuil, and as soon as these could be run to Amiens after that place was occupied, direct communication was at once established *viâ* Creil with Versailles. On the further advance of the Army to Rouen two lines were again established from Amiens to Rouen by Poix-Buchy and Poix-Gournay. After the defeat of the enemy on the Hallue every effort was made to keep up communication between the various scattered portions of the Army. Thus wires were established from Amiens by Corbie to Albert and the neighbourhood of Péronne, and thence prolonged to Combles and Ham. After the battle of Bapaume and the fall of Péronne, these were further prolonged and Amiens connected with La Fère *viâ* Ham. The Army concentrated on the line of the Somme was thus admirably connected by telegraph, the value of which was fully shown in the operations immediately preceding the battle of St. Quentin. In the pursuit which followed the battle the wire was carried from Ham *viâ* St. Quentin as far as Bantouzel.

In the beginning of October, 1870, the 1st Bavarian Army Corps and the 22nd Infantry Division were detached to Chartres and Orleans, and both these places were very soon joined by wire with the line encircling Paris. The first line had to be partially given up after the action at Coulmiers, and Toury then became the terminal station for the forces that had in the meanwhile been formed under the Grand Duke of Mecklenburg. When, however, on the approach of the IInd Army, the latter moved to a position between Chartres and Rambouillet, the line was transferred to Epernon—Nogent-le-Roi. When the Grand Duke advanced in the middle of November towards Le Mans, the wires followed by Nogent-le-Rotrou, the telegraph system in rear receiving at the same time an extension by the establishment of the lines Versailles—Dreux and Chartres—Bonneval—Arpajon. On the further march of the force on Beaugency and afterwards on Toury, telegraphic communication was maintained with Chartres and also immediate connection gained with the lines of the IInd Army from Bonneval by Viabon to Toury.

[1] The lines encircling Paris had a perimeter of some 74 kilometres, with 59 telegraph stations. As the scale of the accompanying map is too small to enable these to be all shown they are given here:—Dammartin, Grand Tremblay, Boissy, Gonesse, Villiers-le-Bel, St. Brice, Montmorency, Sannois, Moulin d'Orgement, Argenteuil, Sartronville, Maisons-sur-Seine, Le Becq, St. Germain, Marly, La Celle, St. Cloud, Etoile, Avray, Meudon Nord, Meudon Sud, Chaville, Versailles, Batterie 4, Clamart, Villacoublay, Villeras, Châtillon, Chatenay, Brièvre, Châtillon (redoubt), Palaiseau, La Rue, Wissous, Villeneuve-le-Roi, Juvisy, Villeneuve St. Georges, Corbeille, Brunoy, Brie Comte Robert, Yères, Gros Bois, Boissy St. Leger, Le Pach Château, La Lande, Fontault, Combault, Gretz, Villiers, Malnoue, Ferrières, Lagny, Brou Esbly, Claye, Chelles, Montfermeil, Raincy, Coubron, and Livry.

The IInd Army in its march from Metz to the Middle Loire had at first two wires from Blesme by Montierender, and from Chaumont-en-Bassigny to Troyes. In the rapid advance of the Army from the line Troyes—Chaumont in a westerly direction, telegraphic communication was prolonged from Troyes by Sens to Nemours, and later on connection was made with Versailles from Pithiviers both by Corbeil by restoring the French lines, and by Angerville.

During the interval which preceded the fighting at Orleans, the wires of the IInd Army were completed, and whilst the fighting was going on they were prolonged as our troops pressed the enemy back, and on the 5th December were established in the town itself. Following the troops that were pushed beyond Orleans, the wires were next laid to Châteauneuf, Beaugency, and La Ferté-St. Aubin.

In the advance of the Grand Duke of Mecklenburg's force (supplied by the IIIrd and Xth Army Corps) in the direction of Tours, the line Orleans—Beaugency was prolonged by Blois to Vendôme. When again in the latter half of December the IInd Army was concentrated in the neighbourhood of Orleans, and the Duke of Mecklenburg's force took up a position at Chartres, the network of telegraphs was increased by the lines Vendôme—Châteaudun—Bonneval, Châteaudun—Orleans, Chartres—Courville and Châteauneuf—Montargis—Gien, and the latter was prolonged on the 31st December to Briare.

In the movement on Le Mans which began in the early days of January, lines were established both from Chartres by Nogent-le-Rotrou and from Vendôme by St. Calais. After Le Mans was occupied it was connected by telegraph with Alençon, Conlie, Château Courville, La Fontaine, and by Tours with Château Renault and Blois. The XIIIth Army Corps in its march from Alençon to Rouen had the line Chartres—Evreux—Rouen in working order by the 24th January, and a wire was afterwards established by Bouchy to Dieppe.

In the southern theatre of operations wires were laid during the siege of Strasburg from headquarters at Mundolsheim to Bendenheim, to the neighbourhood of the siege operations at Kronenburg, to the Baden Division at Oberschäffolsheim, and by Rastatt to the forces at Kehl.

When, after the fall of Strasburg, the XIVth Army Corps marched off in a southerly direction, the line Blainville-la-Grande—Epinal was established joining the main line Landau—Nancy—Paris. Owing to a want of stores, however, nothing more could be done for a time, and it was only after Dijon was taken that the line Epinal-Vesoul was put in working order. In the early part of November, when the Army Corps was so extensively scattered, the want of telegraphic communication was severely felt. There was but one Etappen Telegraph Detachment and very little *matériel*, but notwithstanding this, Vesoul was joined by Lure with La Chapelle and by Gray with Dijon. On the 17th December a wire was laid from Gray by Dampierre to Port sur Saône. These lines contributed in no small degree to the successful concentration in two days of the Army Corps at Vesoul, ordered on the 26th December. The stations at Dijon, Mirebeau-sur-Bèze, and Gray were abandoned, but on the other hand a line was established from Vesoul to the 4th Reserve Division at Villersexel.

When, however, in the beginning of January the Army Corps again moved northwards, the lines that had been laid south of the line Vesoul—La Chapelle, and again at the final concentration behind the Lisaine, the stations west of the Lure as well had to be abandoned, so that communication with the Commander-in-Chief's Headquarters at Versailles could then only be kept up *viâ* Mulhouse. The most important points in the Lisaine position were then connected together and with Headquarters by telegraph within 24 hours, and during the battle which ensued orders and reports passed freely and uninterruptedly, contributing in no small degree to the final victory of our troops. In the movements which succeeded the battle, and for combined operations

with the other parts of the South Army—formed in the meanwhile, and to which the 7th Field Telegraph Detachment had been attached in January—the line Lure—Villersexel—Rougemont, and as our forces advanced further, the line Lure—Vesoul—Gray—La Barre—Byans gradually, as well, were brought into working order.

After the French Army had crossed the Swiss frontier lines were established from La Barre by Dôle to Lons-le-Saunier and Dijon, from Gray to Fontaine Francaise and Auxonne, and by Dijon to Beaune and Montbard.

In spite of their little practice and training at the outset, these recently formed telegraph formations, as they got accustomed to their work, were quite able to meet the severe strain they were put to from so many different quarters, and fully proved themselves both efficient and indispensable factors in the solution of the political and military problems of the moment.

The wires of the Field Telegraphs attained at the close of the campaign a length of 10,830 kilometres, with 407 stations. Of these, 8,252 kilometres were restored French wires, 798 kilometres temporarily laid wires, and 1,780 kilometres field pattern wires.

If to these figures we add the 17,011½ kilometres of wire on poles laid by the State Telegraphs with 407 stations, we get a total of 27,841½ *kilometres of wire with* 569 *telegraph stations*.

A glance at the accompanying map gives some idea of the immense amount of work done by the Military Telegraphs in the war, and, it must not be forgotten, under every kind of difficulty.

In this the share of the work done by the State Telegraphs is the most striking, and certainly without their co-operation anything like the results arrived at would have been quite out of the question. In matters, indeed, outside purely military operations, that is to say, in departmental work, commissariat, postal, and other questions, in the care and transport of the sick and wounded, and in meeting the innumerable requirements of an army numbering over a million of men, the use of the telegraph was invaluable.

And all this was done without interfering with private business at home, which, though it was of course materially affected by the war, was nevertheless carried on as usual.

Our Military Telegraphs, relying as they do for war on the State Telegraphs, is again the cheapest system that can be devised, as may be inferred from a comparison of the cost of our telegraphs in the wars of 1864 and 1866 compared with that of the telegraphs in the Civil War in America in 1860–65.

In the wars of 1864 and 1866, 3,045 and 9,555 kilometres of wire were established by us at a cost of 276,252 and 215,625 marks respectively, giving a total of 12,600 kilometres of wire at a cost of 491,877 marks. This does not include the lines laid by the Field Telegraphs.

In the American War the Federals had at the commencement neither State nor Military Telegraphs, and were compelled to adapt the lines and stations of private companies, and establish new lines and stations with the greatest energy. The cost of some 24,150 kilometres of field telegraph wire, &c., during the four years the war lasted, amounted to 2,655,500 dollars, or 11,353,100 marks, or as 11 to 1 compared with our figures.

This is not an absolutely correct comparison, as the cost entailed by our Field Telegraph Detachments is not included, but on the other hand we have not included the lines they erected, and we have balanced one against the other. Again, the duration of the wars in question is very unequal and ought to be taken into account in the cost of the American lines. But with all this our system is undoubtedly far the cheaper as regards money.

There is, however, another and fairer comparison that may be made, and that is, that whereas the Federals, who possessed no State Telegraphs on which

to have their Military Telegraphs in peace time, only managed to lay 24,150 kilometres in a war which lasted *four years*, we Germans laid 27,841 kilometres in about *one-seventh* of the time.

Seeing then the brilliant results achieved by the Electric Telegraph in the Franco-German conflict, any unprejudiced person must certainly justify the hope of the Officers, *employés*, rank and file, and others of our Military Telegraphs who worked so well and loyally to bring about these results, of expecting that their exploits may be classed as worthy of the great achievements of the other branches of the German Army. This feeling the author fully shares with his fellow-workers, and thanks at the same time all those who have worked so well and cordially with him in enabling him to be of some small use to the Army and Fatherland.

PRACTICAL EXERCISE IN TACTICS.[1]

(Condensed from the Original by Captain J. W. Spencer, Brigade-Major R.A., Chatham District.)

Lieut.-Colonel Schmedes was during a period of five years Instructor in Tactics at the Military School at Vienna, and knowing well how difficult it is to design and carry out practical exercises in this subject, as well as the great importance of arriving at a good method of doing so, has written an account of the practical working of a scheme which he carried out with the students in 1880.

The object of this scheme was to make the students, who had hitherto only been accustomed to study maps and plans, work out tactical problems on an actual piece of country, and help them to thread the labyrinth of difficulties which the formation, nature, and covering of the ground would present to them in the solution of those of the simplest description, to enlarge their knowledge by showing them new examples, and to make them practise sketching with a special tactical object.

His book consists of two parts, an introduction and an account of the work done day by day: the latter gives for each day's work the subject to be considered (whether marching, bivouacking, placing outposts, &c.), a special idea of what is to be done, and a number of problems connected therewith, with their solutions.

These problems were solved sometimes by a *vivâ voce* examination, and sometimes the students had to write reports, with or without sketches. All the work was done out of doors on the ground.

In the following pages will be found—

Part I. A précis of the introduction.

Part II. The subject, special idea, and problems for each day's work.

Part III. The first day's work in detail.

Part IV. An account of the other days' work.

Part I.—Introduction.

The exercises were carried out during seven days, viz., from the 21st to 27th July inclusive.

The party (consisting of the instructor and twelve students) left Vienna on the 20th and slept at Lilienfeld (see Programme of Work); on the 21st they went to St. Veit on foot, and slept there on the 21st, 22nd, and 23rd. On the 24th they went by rail to Wilhelmsburg, where they slept that night and on the 25th and 26th, returning to Vienna on the 27th. During the first four days they worked in one squad, during the other three days eight students formed one squad (the south party), whilst the other four formed another (the north party). They only worked in two squads when their work fell on contiguous pieces of country, so that the instructor could superintend them both. On the 26th the party was joined by Captain Moriz Ritter von Brunner, of the Engineer Staff, Instructor in Fortification at the Military College.

The working hours were from 6 A.M. to 1 P.M. and from 2 P.M. to 4 P.M. The detail of the scheme had been previously worked out by the instructor on the map, so that a short reconnaissance by him was sufficient before the commencement of work by the students, who having arrived at the end of their

[1] "Eine Übung in der Taktischen Thematik." Von Ernst Schmedes, k.k. Oberst-Lieutenant im 47 Infanterie Regiment. Wien, 1881.

academical studies, had already acquired a knowledge of the whole theory of tactics and an intimate acquaintance with all tactical rules, illustrated by many examples on maps, plans, and games of Kriegsspiel.

Partly to demonstrate the duties of a small detachment, as part of a large body, and partly to obtain data for the problems, the situation and duties of each unit, on each day, were first determined by a short *vivâ voce* discourse in the form of questions and answers, from which problems to be worked out independently by the students were fixed on.

Each problem after its solution was discussed by all, and then put on one side.

During their work the students were allowed the use of text-books.

As to the preparing of the scheme, the following had to be settled :—

1. The strength of the forces supposed to be at disposal. This was arranged in conformity with the course of instruction for the academies, which provides examples for small bodies of men of each arm, both acting independently and in combination with other arms.

2. The country where the exercises were to take place. The country chosen was that part within the following limits :—From the line Hohenberg—Türnitz—Frankenfels on the south side, to Losdorf—Rekawinkel on the north ; and from Frankenfels—Losdorf on the west to Rekawinkel—Kaumberg—Hohenberg on the east. This country, in the southern portion, as far as the line Wilhelmsburg—Laaben, bears the character of a lower secondary chain of mountains with an average height of between 600 and 900 metres ; beyond that line, towards the north, it sinks down and becomes merely a hilly country.

Description of the Country.

1. *Elevations.*—The heights are structures of chalk and sandstone, with narrow ridges and steep rocky slopes.

2. *Valleys.*—These are in the southern portion straight, deep, and often precipitous, but in the hilly country to the north they are, though still steep-sided, wider and not so deep.

3. *Nature of the Soil.*—In the valleys mostly stony with small patches of earthy soil. The heights and slopes covered nearly all over with a thick loamy covering, being here and there only rocky in the steep parts.

4. *Covering.*—The higher portion mostly woody ; grassy and enclosed spaces only on the ridges and in the valleys. In the lower northern part arable land preponderating ; but the many woods and undulations giving it a more covered appearance, which is lost in the wider valleys of the Pielach and Traisen.

The trees are nearly throughout high, thin, and destitute of undergrowth, and consist of a mixture of different sorts of foliage trees and firs ; the latter preponderate. The wood is nowhere old, especially in the lower parts, and does not present great difficulties against moving through it, nor does it afford much cover from fire ; it can usually be thinned by infantry in a short time, and without much trouble.

The arable land is covered with corn and potatoes, which offer no obstruction and afford no cover. When digging on the heights we find the soil of an average quality ; in the valleys we find a layer of earth, then stones.

5. *Dwelling-houses.*—The communities inhabiting the narrow valleys usually live in small hamlets, which are commanded from all sides and therefore tactically worthless ; but there are also farmhouses built of stone and partially covered with tiles ; two or three of these buildings joined together like wings, or isolated, affording each other flank defence, often form excellent positions for the defence of the slopes near or under them. Moreover, spring water is found in their vicinity.

6. *Rivers and Streams.*—There is not much water on the mountains. What few springs there are lose themselves very quickly among the stones.

The following are of tactical importance:—

A. The Traisen (breadth, 30 to 50 paces; depth, 0·60 to 1·80 metres; velocity, 1·25 to 1·80 metres per second; bed, rocky; banks, 1 to 3 metres high with thick brushwood) is nearly always passable, though not without difficulty.

B. The Gölsenbach (breadth, 15 to 25 paces), in other respects like the Traisen, and as easily passable.

C. The Eschenauerbach (breadth, 5 to 10 paces), in other respects like the foregoing, but more easily passable.

D. Canals.—These in the Traisen and Gölsen Valleys are 1 to 1·80 metres deep; 1 to 4 metres broad, usually revetted with wood, and therefore only passable for cavalry and artillery by the bridges.

Thus the water channels form nowhere an absolute hindrance, but demand care from the tactician, since the forced passage of most of them in the presence of the enemy without the necessary preparation might be disastrous.

7. *Communications.*—The roads in the principal valleys are in very good order. The country roads and cart roads are, as a rule, likewise good, only sometimes very steep and, in the sunken roads, reduced to the ordinary country track. In the lower parts they could easily be made practicable for heavy field guns, but they should not be used by them without previous reconnaissance.

Résumé.—From a military point of view, it may be stated that the confined space, want of shelter, of provisions, and of water, in the south portion of our country prevents the movement of large bodies of men; that the middle portion, richer and more passable, is more adapted to the military requirements of a brigade, or even a Division; and that the north portion is nearly throughout an ideal manœuvring country, with enough water for large Army Corps.

The reasons for choosing this zone of country with a direction of operations north and south were: that in the south portion the very difficult nature of the country required from the students a searching reconnaissance of the line of march, and it exemplified to them the great difficulties of movement, giving opportunities for explaining the difference of calculating, by time and by space, the movements of troops of all arms, and the great relative differences between heights and depths, showing them the advantages and disadvantages of commanding firing positions, the numerous defiles, the value of necessary space for deploying for action, whilst the want of cover, of provisions, of space for pitching camps, and even of water, showed them what great consideration was required for the choice of halting places and positions; shortly, that it was very favourable for an introduction into the details of troop-leading. That in the middle portion, not so mountainous, but affording views sufficiently extensive, the situation of affairs at any moment could be quickly grasped, whilst the increased freedom of movement for all arms tended to exemplify to the students their more intimate co-operation, and that in the northern portion the advantages and disadvantages of free manœuvring spaces, without exceptionally high commands, were easily explained to them, as also the full value of cavalry and horse artillery, the great defensive strength of positions with an extended gently sloping foreground, but with the overwhelming difficulties in directing the defence, owing to the many opportunities of sudden attack open to the enemy; and finally, the relatively reduced power of resistance of smaller bodies in comparison to that possessed by them on more difficult ground.

Partly to facilitate the fixing on the positions of our forces with reference to other forces, and partly to demonstrate to the students how the development of force determines the conduct of the smallest detachments as well as

that of larger bodies, it was considered that tactically they acted quite independently; but that strategically (on account of their combination with other portions of the army) their action was, as much as possible, confined within narrow bounds. It was explained, however, to the students, how his situation of co-operation with others must be understood and continually considered by each commander, so that whilst making every effort to contribute towards the success of the main idea, he should not by any means run the risk of compromising its success by untimely daring or cunning, by attacking too soon or retiring too late, by not making proper use of the ground to cover his movements, &c.

It was also explained to them how necessary it was for each commander to afford to his subordinates an insight into his plans, and to point out to them clearly, as much as possible, their part in them, so as to make sure of their utmost assistance.

Lastly, it was pointed out to them how the possession of an important strategical position was the basis for all projects.

The General Idea of the Scheme, Summary of Events, and Programme of Work for the Students, prepared by the Instructor and approved by the Imperial War Ministry, were as follows:—

I. General Idea.

A. *Southern Army.*

1. An army marches through Upper Styria by way of Bruck on the Mur against Vienna.

2. The main body arrives near Wiener-Neustadt on the *n*th, the vanguard in the line Leobersdorf—Ebenfurth.

3. To cover the left flank of the army against enterprises from St. Pölton, a combined brigade is detached from Bruck on the Mur by way of Mariazell—Traisen (at the mouth of the Gölsenbach).

This brigade arrives at Türnitz on the $n-1$th. On the *n*th it reaches Traisen, where it will receive further instructions, according to circumstances.

B. *Northern Army.*

4. An army is concentrating on the Middle Danube, between Vienna and Pressburg. The passages of the Danube at Krems, Tulln, Vienna, Hainburg, and Pressburg are covered by advanced detachments.

5. For the security of the passages at Tulln and Krems, a combined half-brigade is posted at Neulengbach.

Note.—The problems were, with reference to the conduct of the Southern Army detachment, near Traisen, and its opponents. The Summary of Events was deduced from the General Idea.

II. Summary of Events.

On the n*th.*

Southern Army	*Northern Army*
advances on Vienna Neustadt. The combined brigade marches from Türnitz to Traisen.	is concentrating on the Danube. The half-brigade at Neulengbach reconnoitres the southern part of the Vienna Forest.

On the n + 1*th.*

Reconnoitres as far as the Danube; the main body concentrates about Wiener—Neustadt. The combined brigade reconnoitres towards Neulengbach and St. Pölten, and begins, at the same time, the erection of a defensible barrier across the valley near Traisen, so as to spare more men to reinforce the army.

Concentrates near Bruck on the Leitha. Part of the army covers Vienna.

The combined half-brigade at Neulengbach proceeds to reconnoitre the enemy at Traisen, and covers the passage at Krems against the advance of the enemy by a flanking movement towards St. Pölton.

On the n + 2*nd.*

Marches on Vienna. Main body of combined Brigade X moves off to Aland, in order to take part in the impending struggle. The remainder of the brigade holds the valley barrier now completed and proceeds to fortify it.

Advances against the flank of the Southern Army. The half-brigade from Neulengbach makes a demonstration by way of Aland against the left flank of the hostile army. A detachment of the same covers the passage at Krems and observes the enemy at Traisen.

On the n + 3*rd* (day of battle).

The detachments near Aland neutralize one another; the wing detachments observe one another.

On the n + 4*th.*

The Southern Army has been beaten.

The Southern Army retires on Neustadt. For the security of the left flank in a further retiring movement, the combined brigade (Brigade X) is again concentrated on Traisen. The half-brigade marches from Aland on Hainfeld, so as to hinder the pursuit by the hostile forces through Kaumberg or Laaben.

The detachment at Traisen re-enters into the brigade command.

The Northern Army seeks to force the enemy away towards the west, or at least to confine him to the road over the Semmering.

To threaten the enemy's retiring line towards Bruck on the Mur, a combined brigade (from the garrison from Vienna) is thrown, by railway, into Krems, in order to press on by Traisen and Mariazell.

The Neulengbach detachment has to screen the railway transport, eventually advance against Laaben, and occupy the passages in the Gölsen Valley, or hold in check the forces there, and then join the brigade at Traisen.

On the n + 5*th.*

The army retires on Neunkirchen; a strong rear-guard seeks to delay the pursuit by the enemy.

The Brigade X endeavours to defeat the scattered hostile forces, and thus to fulfil its task.

Pursues the hostile army.

The brigade which had concentrated at St. Pölton on the $n + 4$th advances on Traisen; the Neulengbach detachment, which on the $n + 4$th had advanced as far as Laaben, seeks to

The eastern column of the enemy is held fast by a weak detachment at Laaben; whilst the concentrated main body of Brigade X involves the western column of the enemy in a decisive combat at Wilhelmsburg, and defeats it.

hold fast the enemy's forces at Hainfeld.

The programme of work for each day is given in the table, page 1071.

Part II.

Subject, Special Idea and Problems for each day's Work.

First Day's Work.

Subject: Security on the Line of March.

I. Special Idea.

A. *Brigade X.*

1. Order of battle and disposition of Brigade X (Southern Army) on the evening of the $n-1$th as follows:—

Corps.	Distribution.	Station.	Description of Troops.	Strength. Battalions.	Companies.	Squadrons.	Guns.
Brigade X.	Main body	Türnitz	Infantry	4½			
			Cavalry	..	..	⅛	
			Heavy field batteries.	..	..	..	8
			Engineers	..	¼		
	Advanced guard.	Lehenrotte .	Infantry	1½			
			Cavalry	..	..	¾	
			Mountain battery ...	..	..	..	4
			Engineers	..	¾		
	Flank detachments — Right...	Hohenberg .	Rifles	¾			
			Cavalry	..	..	⅛	
	Flank detachments — Left....	Kirchberg ..	Rifles	¼			
			Cavalry	..	..	⅛	
			Total	7	1	1	12

The Staff at Türnitz.

Attached to the brigade: A field signalling party and detachments from the Ammunition Reserve, Sanitary Branch, and Supply Train of the Division.

2. Information about the enemy. Weak hostile detachments are reconnoitring in the Vienna forests.

III. PROGRAMME OF WORK.

Working day.	Subject of problems.	Ordre de Bataille.		Movements of the students.	Night stations of students.
		Southern Army.	Northern Army.		
1	*Security on the Line of March.*—Advance of the Southern Brigade (combined brigade) from Türnitz to Traisen. Passage of the Schrambach defile. Repulse of the enemy's advance guard.	Combined brigade— 7 battalions. 1 heavy field battry. 1 mountain „ 1 squadron. 1 co. engineers, &c.	1 battalion. .... ½ squadron. 2 mountain guns.	From Freiland (south of Lilienfeld) to Traisen (on foot)	St. Veit. *Remarks.*—The squad goes on the 20th from Vienna to Lilienfeld and spends the night there.
2	*Choice of Camp* for the Southern Brigade near Traisen.	Ditto.	Ditto.	.. ..	Ditto.
3	*Protection of a Camp.*—Placing outposts for the protection of the camp near Traisen towards the east.	..	..	.. ..	Ditto.
4	*Laying-out a Defensible Barrier* across the valley near Traisen, so as to be able to spare more men for the fight.	Ditto.	..	After the work, by rail to Wilhelmsburg.	Wilhelmsburg.
5	A. *Southern Party. Preparing for an Action.*—Choice of and disposition for a battle-field. B. *Northern Party.*—Orders for a march when anticipating a battle	Ditto.	9 battalions. .... 2½ batteries. 1 squadron. 1 co. engineers, &c.	*Remarks.*—The work is carried on in two parties, viz., Southern Party 8 students; Northern Party 4 students.	Ditto.
6	*Commencement of the Action* near Wilhemsburg.	6 battalions. ..... 1 heavy field battry. ½ mountain „ ¾ squadron. 1 co. engineers, &c.	6 battalions. 2 batteries. ½ squadron, &c.	The latter, on the forenoon of the 5th day work's out in detail with Captain von Brunner, the project for the defensible barrier in the valley.	Ditto.
7	*Carrying out a Decisive Fight* near Wilhelmsburg.				
	Recapitulation (*vivâ voce*) of the whole work.	Ditto.	Ditto.	Return by rail to Vienna	Vienna.

B. *Half-brigade Z of the Northern Army.*

1. Order of battle and disposition of the Half-brigade Z on the *n*th, as follows :—

Corps.	Distribution.	Station.	Description of Troops.	Strength. Battalions.	Companies.	Squadrons.	Guns.
Half-brigade Z.	Main body ...	Neulengbach..	Infantry	2½			
			Cavalry	..	..	¼	
			½ Light field battery.	..	..	..	4
	Detachment No. I	Scheibmühle on the Traisen	Infantry	1			
			Cavalry	..	..	½	
			½ Mountain battery ..	..	..	..	2
	Detachment No. II	South of Laaben	Infantry	¼			
			Cavalry	..	..	$\frac{1}{16}$	
	Detachment No. III	Klausen-Leopoldsdorf	Infantry	¼			
			Cavalry	..	..	$\frac{3}{16}$	
			Total	4	..	1	6

II. Summary of Events.

1. Brigade X advances on to the line Hainfeld—Traisen—Rabenstein.
2. The main body from Türnitz to Traisen halting an hour *en route* at Schrambach, after passing through the Schrambach defile.
3. At Lilienfeld the advanced guard come upon the leading hostile cavalry scouts, who retire towards the north.
4. To the north of Traisen it is forced to deploy by Detachment No. 1 of the Half-brigade Z (Northern Army), which has taken up a position behind the Gölsenbach on the slope of the Steinwandleite, and looking into the Traisen Valley.

Reinforced from the main body the advanced guard crosses the Gölsenbach at Wiesenfeld, and the enemy retires on Wilhelmsburg.

The main body encamps near Traisen, and places outposts.

III. Programme of Work.

Problems.

1. An advanced guard marching to the front through a defile, and the orders to be issued by its commander.
2. Command of a detachment employed for protection (Sicherungs-dienst).
3. Command of an advanced patrol.
4. Dispositions for a party of cavalry reconnoitring at a great distance.
5. Command of a reconnoitring patrol.
6. The deployment of the advanced guard and its reinforcement by the main body, on contact with the hostile detachment near Traisen.

Second Day's Work.

Subject: Selecting and preparing a site for bivouacs.

I. *Special Idea for the second day's work.*—On the *n*th the Brigade X of the Southern Army sends on from the halting place near Schrambach a party to choose and prepare a site for bivouacs near Traisen. They commence their work as soon as the hostile portions have been driven far enough back. The work is not interrupted.

II. Programme of the Day's Work.

Problems.

1. Determining the situation of the bivouacs with reference to the strategical duties of the brigade.
2. Determining the distribution of the brigade, in its bivouacs, with reference to the tactical situation.
3. Determining on the strength and composition of the several groups.[1]
4. Choice of camping-grounds for individual groups.
5. Preparing the camp of one of these groups.
6. Carrying out the technical work of a camp.

Third Day's Work.

Subject: Placing outposts.

Programme for the Director of the Operations.

I. *Special Idea.*—On the night of the *n*th after the hostile detachment has retired to Wilhelmsburg, Brigade X bivouacs (as discussed in last day's work) where the road forks near Traisen and for its security places outposts; no interruption is offered.

II. Programme of the Day's Work.

Problems.

1. Discussion on the questions which the Brigadier must solve, before issuing orders with respect to placing outposts.
2. Determining the position of the outposts.
3. Drawing up orders for the conduct of the outposts.
4. On the duties of the outpost commander whilst the outposts are being posted.
5. On the duties of a post commander, whilst the outpost groups are being told off to their several positions.
6. On the advisability of entrenching portions of the ground, as increasing the defensive power of the line of supports.

Fourth Day's Work.

Subject: Laying out a defensible barrier across a valley.

I. *Special Idea.*—The Commander of the Southern Army is determined to attack the enemy's forces near Vienna, on the right bank of the Danube, and to hold fast, by means of demonstrations, those which have assembled near

[1] A group means advanced guard, or main body, or reserve, &c.—J. W. S.

Bruck on the Leitha, and those in the Vienna Forest. For this purpose he seeks to reinforce as much as possible the main body of the army.

In order to bring up a portion of Brigade X, without thereby endangering his retreat over the Semmering, by way of Bruck on the Mur, he orders its commander (so as to enable him to send as strong a portion of his brigade as possible at daybreak on the $n + 3$rd to reinforce the army on that day, to Altenmarkt) to employ all his available forces to entrench the roads in the Traisen and Gölsen Valleys near Traisen, in such a manner as to be able to hold them with a small force.

II. Programme of Work.

A. *General Problems.*

1. The value of a barrier near Traisen.
2. Determining its situation.
3. Determining the necessary works and their occupation (General Project and Special Projects).
4. General plan of defence.

B. *Special Technical Problems.*

5. Detailed project for the erection of the different works.
6. The duties of Engineer Officers superintending their construction.

Fifth Day's Work.

Subject: Preparing for an action.

I. *Special Idea.*—The Commander of Brigade X receives at Traisen information that the enemy is advancing against the brigade in two columns (one from Neulengbach by way of Laaben, the other from Krems through St. Pölton). He determines to engage them separately, before they can unite, and makes arrangements accordingly.

The Commander of the Northern Army Forces near Laaben and St. Pölton, having received intelligence concerning the divided position of Brigade X, determines to hold fast the forces at Hainfeld with his detachment near Laaben and force his detachment at St. Pölton between the two parts of the enemy (on St. Veit), compel them to abandon their line of retreat on Mariazell, and so open the way for himself against the flank of the retiring hostile army.

II. *Programme of Work.*—The detachment of students was divided into two parties, of which one solved the problems of Brigade X, the other those of the Northern Brigade.

Problems.

Southern Brigade.	*Northern Brigade.*
1. Determining the strategical situation of Brigade X on the $n + 4$th.	Determining the scheme of advance of the column from St. Pölton on St. Veit.
2. Determining the means of deceiving the hostile forces near Laaben, as to the concentration of the brigade.	On the distribution of forces for the advance and security of the same.
3. The action of the main body of the brigade against the St. Pölton column, viz.:	*Remark.*—This party worked out in the forenoon of this day with Captain Ritter Von Brunner, both

A. Freedom of action with reference to time and space.
B. Choice of the manner of conducting the fight.
C. Fixing on the idea of the fight.
D. Determining the chief points in the plan of action.

4. Preparing for a decisive action against the St. Pölten column, viz.:
A. Entrenchment on the field of action, &c.
B. Distribution of forces on the field.

detail problems concerning the defensible barrier in the valley; in the afternoon with the instructor both the above problems, whilst Captain Von Brunner and the other party worked at the detailed scheme of defence of the position at Göblasbruck.

Sixth Day's Work.

Subject: The commencement of an action.

I. *Special Idea.*—A. The Southern Brigade concentrates in the position near Göblasbruck early on the morning of the $n + 5$th. A detachment of the same seeks to hold fast the hostile half-brigade at Laaben, whilst a weak detachment near Kirchberg covers the left flank of the brigade.

The commander endeavours in carrying out his plan of action to lead the enemy to make a hasty advance and attack his position.

B. Intelligence, according to which his half-brigade at Laaben ought to be able to keep the enemy's forces from uniting, till towards midday, has reached the Brigadier commanding the North Brigade early on the morning of the $n + 5$th. He therefore holds fast to his preconceived plans, and at daybreak advances south. At Wilhelmsburg he finds a portion of the enemy in an entrenched position, round which there is no feasible route, because they have destroyed all the passages over the Traisen. He therefore decides to commence an action, and if circumstances are favourable to attack.

II. Programme of Work.

A. South Party.

1. Reconnoitring a defensive position by a party of cavalry ($\frac{1}{2}$ squadron).
2. Employing a company of infantry as escort for guns.

3. The employment of guns ($\frac{1}{4}$ battery) with an advanced guard.

4. Directing the fire of the guns with an advanced guard, before a defensive position.
5. Command of a company as escort to guns, repulsing an attack by hostile infantry.
6. On the employment of artillery at the commencement of a defensive-offensive action.
7. On the results of the preliminary fighting with reference to the preconceived plan of action.

B. North Party.

Reconnoitring along the line of advance by a party of cavalry ($\frac{1}{2}$ squadron).

The command of a company, as vanguard along the line of advance.

The command of a company, as vanguard, when a collision with the enemy occurs.

Command of the artillery at the commencement of an action.

Deciding as to the result of the preliminary fighting and determining on further action.

Deciding on the plan of action according to the results of the preliminary fighting.

Seventh Day's Work.

Subject: Fighting a decisive action.

I. *Special Idea.*—This is already determined, for each side, by its plan of action.

II. Programme of Work.

Problems.

A. *South Party.*	B. *North Party.*
1. Discussion on the holding of a position exposed to artillery fire.	On preparing the attack by artillery.
2. Command of a company in 1st line on the approach of hostile infantry.	Leading a subordinate attack.
3. Employment of the partial (battalion) reserve on the approach a hostile infantry attack.	Leading the pretended attack.
4. Employment of the defensive reserve on the forward rush of the hostile infantry attack.	Directing the artillery fire in preparing the way for the principal attack.
5. Employment of the artillery against the principal hostile attack.	Carrying out the principal attack.
6. Employment of the offensive reserve in a counter-attack.	Employment of the 3rd line to repulse the counter-attack.

It will be observed from the foregoing that the 1st, 2nd, 3rd, and 4th days' work was carried on close to Schrambach and Traisen, whilst the 5th, 6th, and 7th days' work was in the neighbourhood of Wilhelmsburg.

All the work on the first four days was in connection with the movements and doings of Brigade X on the nth, $n + 1$th, $n + 2$nd, with the exception of the sketching on a map the position of the Northern Army on the $(n - 1\text{th})$ &c.

Part III.

First Day's Work (in detail).

The students having slept at Lilienfeld, proceeded on foot from Freiland, south of Lilienfeld, towards Traisen. They had previously been each given two sketches of the country; the one representing the northern part, the other the southern part. On the first-named, which was on a scale of $\frac{1}{1200000}$, they had to draw the positions of the Northern Army on the $n-1$th and its probable position on the nth. On the other sketches, on a scale of $\frac{1}{576000}$, they had to mark the positions of Brigade X, on the night of the $n-1$th, and its probable lines of advance on the nth.

These tasks were partly carried out in accordance with the general idea and summary of events of the scheme, with which the students were acquainted; partly according to the special idea for the first day's work, partly from instructions furnished by the instructor, and partly (especially with reference to the second sketches) from their own observations of the country, to reconnoitre which they were allowed a certain time.

After this they met the instructor at a previously arranged place, and discussed with him (*vivâ voce*) by questions and answers—

Problem 1. On an advanced guard marching through a defile, and the orders to be issued by its commander in accordance with his instructions[1].

[1] The answers here given, and throughout, are presumably the correct solutions to the questions.—J. W. S.

At the same time as when he issued out the sketches, the instructor had supplied the student with the following instructions (being the same as issued to the commander of the advanced guard) :—

Information.—The main body of the brigade advances on Traisen tomorrow.

It will reach Schrambach at 7.30 A.M. and halt there for one hour. The right flank detachment from Hohenberg marches into the Hallbach Valley and halts at Klein-Zell at the same time.[1]

The left flank detachment will remain at Kirchberg in the Pielach Valley during the halt.

No fresh intelligence has come in concerning the enemy.

Detailed Dispositions.—The advanced guard to march at daybreak (on the *n*th) through the Schrambach defile, secure the *débouché* until the arrival of the main body, and cover the main body during the halt.

After passing the defile, cavalry patrols must be at once pushed on towards Wilhelmsburg in the Traisen Valley, Hainfeld in the Gölsen Valley, and Hofstetten in the Pielach Valley. Connection with the right flank detachment must be sought through the Upper Wiesenbach Valley, and with the left flank detachment by way of Kristenthal. Intelligence to be sent every half-hour after daybreak. To facilitate this, a party of orderlies will be established at Lehenrotte.

Should the passing out of the defile by the advanced guard be hindered, or should the position in front of it have to be evacuated before the attack of overwhelming forces, the heights on both sides of the defile must be firmly held, so as to close the defile to the enemy and enable the main body to ascend the slopes.

The fighting train[2] accompanying the advance to be limited. The rest of the train to close up on one side of the road until the main body has passed, when it will move on in rear of the brigade fighting train.

Question 1 (by the Instructor).

What duties do the instructions received by the commander of the advanced guard comprehend?

Answer.

1. Securing the *débouché.*
2. Reconnoitring towards Hainfeld, Wilhelmsburg, and Hofstetten.
3. Seeking connection with the flank detachments.
4. Precautions for the speedy transmission of intelligence.
5. Division of the fighting train.

Question 2. Would it be advisable to send on the cavalry, accompanied perhaps by a detachment of infantry in carriages, in order to obtain early possession of the *débouché?*

[1] The detachment need not pass through the *débouché* of the Hallbach Valley at Klein-Zell, because without doing so—

1. It can reconnoitre to the road in the Gölsen Valley by means of patrols.
2. It is better secured against surprise, which is important considering its strategic-defensive duty (security of the flank of the brigade).

[2] In the Austrian Service the "Army Train" is divided into three parts, viz. :—

1. *The Fighting Train,* which comprises all that is required for going into action, and the immediate requirements of the troops when forming a bivouac.
2. *The Baggage Train,* comprising whatever is not required for the immediate wants of the army.
3. *The Supply Train,* formed of the supply column.

The Fighting Train and Baggage Train combined form what is designated the *Little Train;* the Baggage Train combined with the Supply Train forms the *Great Train;* and a combination of all three forms the *Entire Train.* The whole Train accompanied by the Reserve Establishment of the 2nd Line is called the *Great Army Train.*—J. W. S.

Answer. The cavalry (or even a small combined command) would not possess any great power of resistance. Since there is no strong defensive position for so small a party at the *débouché*, no advantage would be gained by pushing it on: on the contrary, it might prove dangerous, in that stronger parties of the enemy would be attracted and the detachment might receive a check before the main body of the advanced guard could come up, and the passing out of the latter would become much more difficult.

Question 3. Is there a fair probability of reaching the Schrambach defile unmolested?

Answer. According to intelligence received, there must be hostile detachments in the Vienna Forest. Since it must be their object to reconnoitre and eventually hinder the advance of our army, it is obvious that the enemy will watch the *débouchés* from the mountains and possibly (in order to retard our advance or to make a forced reconnaissance of the dispositions of our forces) attack the heads of columns as they pass out. Thus a collision with the enemy in front of or even in the defile lies within the bounds of possibility, or even of probability.

Question 4. With reference to this possibility of a collision, how is the question of "reaching and securing the *débouché*" to be solved?

Answer. In accordance with—

a. The orders for the passing of the Schrambach defile.

b. The orders for the security of the *débouché.*

Question 5 (A). What steps must be taken in advancing through a long defile, when a collision with the enemy in it, or in front of it is imminent, and when the ground on the flanks is not absolutely impracticable?

Answer 1. Passage *en masse;* strong advanced guard of infantry and some guns; concentrated column, small distances; broad formations; divided trains.

2. Security of the flanks by pushing forward strong flank detachments on all possible hostile lines of advance, and towards all positions which might be threatened by the enemy.

3. Combination of infantry and artillery in the heads of columns, according to the nature of the country in and in front of the defile.

4. Presence of engineers with the advanced guard, and even with the flank detachments, for the restoration or destruction of roads, and, if necessary, for the placing of the ground in front of the *débouché* in a state of defence.

5. Holding cavalry and artillery in readiness in rear of the head of the column (which is strong enough to force the passage), so as to be able to at once support it in the defence of the *débouché.*

Question 6. What lines of advance or points on the slopes of the Schrambach defile are to be included within the zone of security?

Answer. On the right slope, the road from Freiland on to the Klumberg as far as the ridge north of the Pichler.

On the left slope, the road over the Himmel to Schrambach, thence on to the Linden-Berg, have to be secured.

Question 7. When must the advanced guard right flank detachment march in order to be able to gain and maintain the necessary start?

Answer. Although the main road in the valley is within range of guns on the right slope, on the other hand only mountain pieces can be got up these steep inclines, so a start of 3,500 to 4,000 paces is enough to begin with. This column would thus be at that point where its way turns from a direction parallel to the main road, eastward on to the ridge. This start is also sufficient for the security of the main body until it passes out of the defile, because, although further on from this point the view into the valley ceases, the column can in any case reach and take possession of the ridge, for the security of the passing out, sooner than the main body could reach the further end of the defile, as they would have only 1,500 paces to get over and an

ascent of not more than 130 metres to surmount, whilst the main body has more than 4,000 paces to the *débouché*.

To reach the assigned spot, the right flank detachment requires—

From Lehenrotte to Freiland, 3,000 paces on an even good road (110 paces per minute)	=	27 minutes.
From Freiland to where the way turns eastward on a good cart-road, 2,000 paces horizontal distance	=	18 „
300 metres ascent on a good road (100 metres = 15 minutes)	=	45 „
5 minutes halt	=	5 „
	Total	1 hour, 35 minutes.

Question 8. What considerations determine the strength and composition of a covering detachment generally, and of the right flank detachment in particular?

Answer. In determining the strength, we must consider—

1. *The Proximity and Strength of the Enemy.*—According to intelligence received, the Vienna Forest is occupied by a hostile detachment. Since nothing is known about its strength (but we know that its main body is concentrating near Vienna), an attack with equal or even superior forces is not impossible. Therefore, the covering parties generally should be as strong as possible.

2. *The Importance of the Lines or Points to be secured.*—The possible lines of movement for the enemy against our main body in the defile or at its egress are—

a. Vienna or Tulln, Laaben—Hainfeld—Schrambach.
b. Krems—Wilhelmsburg—Traisen—Schrambach.

In connection with an advance of a detachment in the Vienna Forest the first of these seems the most probable. With reference to this forward movement of the enemy, it seems likely that he will endeavour to hold fast the main body as it comes out of the defile, and surround it from the Klumberg on its right flank; hence we see that the line of movement of the detachment is a very important one, and therefore must be well secured.

3. *The Nature of the Country.*—The duty of the detachment is to delay the advance of the enemy, until such time as reinforcements from the main body of the advanced guard or of the brigade itself can arrive. Because the enemy can only advance along the mountain road, and the adjoining ground only allows room for the deployment of small bodies of infantry, at most of the strength of a company, and affords no view, his forward movement can be easily delayed by a weak detachment.

4. *The Possibility of Support from a Flank or from the Rear.*—From a flank the detachment can receive no support; from the rear only on the road from Freiland, and therefore will probably have to remain alone, opposed to the enemy for about an hour. As the country on each side of the way is not altogether impracticable, and the enemy might by making use of it get round it in that time, it will be necessary to have a reserve force with the detachment, which will thus be stronger than the simple covering of the ground adjoining the way would require.

5. *Its Duties in connection with other Detachments, &c.*—The detachment facilitates the advance in the valley for the advanced guard very much, and is therefore, even if it does not come in contact with the enemy itself at all, a well employed force, and can always be made stronger without danger to the main object of the advanced guard.

Résumé.—In favour of a proportionate greater strength of this detachment we must therefore consider—

1. The proximity of the enemy, and our ignorance of his strength.

Plan of the Dispositions of the Advanced Guard up to the halt of the Main Body at Schrambach.

Columns and commanders.	Detail.	Time of marching.	Duty respecting measures for security.	Order and formation of march.	Eventual object.	Remarks.
I Major M.	Right flank column .. ½ battalion. 2 mountain guns. 1 signalling party.	4 A.M.	Security against observation and attack from the heights and to preserve contact with the advanced guard.	.. ..	Attack with energy or resist hostile forces, until reinforcements arrive. Support the advanced guard according to their power.	After the advance of the new advanced guard, march in towards Lilienfeld.
II Colonel A.	Main body..... ¾ battalion. 2 mountain guns. ¾ squadron. ½ engineer company. 1 pioneer detachment. Fighting train (rest).	5.35 A.M.	.. ..	*Advanced Guard.* ¼ company. *Main Body.* Infantry. Artillery. Cavalry. In close order of march.		
III Capt. N.	Left flank column.... ¼ battalion. Signalling party.	4 A.M.	As above	.. ..	As above	As above.

2. The importance of the line to be secured.
3. The long isolation of the detachment.
4. The advantages derived from it by the advanced guard.

But against it—

The difficulties which the ground presents to a speedy advance of hostile forces stronger than about one infantry battalion.

In determining the composition—

1. *The necessary Reconnaissance.*—The reconnaissance can only be acccomplished by infantry; small patrols of from 4 to 6 men will suffice.

2. *Delay to be obtained by the Resistance to be offered to the Enemy.*—For this purpose 1 to 2 companies of infantry with from 2 to 4 mountain guns in the 1st line, and 1 to 2 companies in reserve (total, 2 to 4 companies and 2 to 4 mountain guns) are sufficient. Engineers need not accompany them because the way is good for foot soldiers and mountain guns, its eventual destruction to delay the enemy's advance cannot now be determined on, and the strengthening of the scene of the impending struggle, owing to the complete absence of positions, is not to be thought of.

3. *The Transmission of Intelligence.*—Messages can be carried personally only by infantry soldiers; indirectly by signalling, for which there is a good place for a station where the way turns to the east.

4. *The Facilitating of Support.*—This is not possible here, because the way cannot be made practicable for field guns in a limited space of time, and shorter communications with the valley cannot be made available.

Résumé.—Thus the detachment should consist of from 2 to 4 companies of infantry and 2 to 4 mountain guns, with a field signalling station.

Question 9. Does this strength and composition of the detachment meet the requirements of the second duty of the advanced guard, "security of the main body during its halt at Schrambach"?

Answer. Yes; became for this purpose the detachment can be pushed forward as far as Höllhald, and the nature and formation of the country on the right flank do not essentially change.

This problem was concluded by determining on the substance of the dispositions of the commander of the advance guard, which the instructor made out according to the preceding table, from which the basis for the next problems was deduced.

Remarks.—1. The Staff accompanies the main body.

2. The flank columns have to leave their knapsacks behind.

3. Cavalry orderlies (1 non-commissioned officer and 4 men) march at 4 A.M. with the right flank column, and proceed to Freiland, and stay there until the main body of the brigade arrives.

4. The disconnected part of the fighting train stays at Lehenrotte, and joins the rear of the brigade fighting train.

5. After leaving Lilienfeld the cavalry commence reconnoitring on a wider front, and keep up the connection between the columns.

After this the students proceeded to solve Problem II. Of the questions thereon, Nos. 1, 2, 3, and 5 were answered *vivâ voce*, whilst No. 4 required a written report. They were told to consider themselves each as the commandant of the right flank column (Major M), and were furnished with the following data:—

1. *Situation.*—It is 10 P.M. on the $n-1$th. The Brigade X advanced guard is at Lehenrotte, and is covered by outposts. The Brigade Commander has published his orders for the nth at 9 P.M. Conformably with these the advance guard commander has planned his programme, and then summoned the commanding officers in order to communicate his dispositions to them.

Duty.—He entrusts you (Major M) with the command of the right flank column of the advanced guard, and gives you the following orders:—

A. Information (for all).

1. *General Situation.*—The brigade remains to-day at Türnitz, and to-morrow will advance to Traisen-Scheibmühl, at the mouth of the Gölsen.

The advanced guard will to-morrow at daybreak advance through the Schrambach defile, seize the *débouché*, and cover the brigade, which will halt for one hour after its arrival.

After this the advanced guard will be relieved.

The right flank detachment of the brigade marches from Hohenberg towards Hainfeld. It will halt at Zell, in the Hallbach Valley, at 7·30 o'clock.

The left flank column of the brigade advances from Frankenfels to Kirchberg in the Pielach Valley.

2. *Intelligence concerning the Enemy.*—No fresh information has come in; nevertheless it is to be expected that the forces in the Vienna Forest will observe the Schrambach *débouché*, and perhaps will try to stop or hinder the brigade as it passes out.

3. *My own Plans.*—I intend to pass the Schrambach defile at daybreak, occupy the heights in front of the *débouché*, and then with the cavalry search the ground lying in front, and seek connection with the flank columns of the brigade. Should the enemy attempt to hinder the passing out, I shall endeavour by reinforcing one of the detachments on the valley slopes to surround and force him back. An advance of the enemy into the defile, or on the slopes of it, must be stopped at any price.

4. *Distribution of the Forces.*—The advanced guard will move in three columns, viz.:—

Column 1. Right flank detachment, under Major M., marches from Freiland, on the right slope of the valley, on to the heights east of the *débouché*.

Column 2. Main body under my command advances along the main road.

Column 3. Left flank detachment, under Captain N, advances along the left slope of the valley, on to the heights west of the *débouché*.

The flank detachments will receive 3,000 or 4,000 paces start, and march without knapsacks; the main body will march with a reduced fighting train.

I will march with the advanced guard main body, and after the passing out will be found on the high road, north of Schrambach, near the Griesler.

B. *Detailed Dispositions (for the Right Flank Detachment).*

a. Strength, Composition, and Equipment.—The detachment will be composed of—

½ a battalion of the "A" infantry regiment;
½ of the mountain battery; and
A signalling party.
Each infantry soldier to carry 100 rounds of ammunition.

b. Hour of March.—The detachment will march at 4 A.M.

c. Line of March and Destination.—It marches in the valley as far as Freiland, thence along the footpath which leads up along the right slope of the valley to the Klumberg, between which and the Vorder Alp it crosses the ridge, and then advances along the cart road eastward as far as the junction of roads near the Pichler, whence it can command a view towards the northern heights, as well as towards the Wiesenthal.

d. Duty.—To reconnoitre the country east of the defile, drive away small hostile parties, and to hold stronger ones in check, until reinforced. Connection with the advanced guard of the main body must be maintained. The signal station will be on the last spot where a good view is to be had, before the road turns eastward.

Should the column reach this spot before the advanced guard reaches Freiland, it must wait there.

Such a position should be taken up by the Pichler that any forward movement of the enemy on the northern heights, between Traisen and the Wiesenbach Valley, or out of this valley, against the main body during their halt, can be speedily discovered and effectually delayed.

e. Measures to be taken in case of a Collision with the Enemy.—Stronger hostile bodies to be attacked with energy, and in any case if they advance against the defile, to be delayed until the arrival of reinforcements. The detachment must make every effort to prevent itself being surrounded, but must not on that account divide its forces. It must eventually protect the advanced guard from any attempts of the enemy to surround it during its advance.

f. Reports must be sent at least every Two Hours.—After the advance from the Klumberg, to facilitate this, a party of orderlies will be established at the point where the ascent to the Griesler branches off.

g. Other Orders.—

After allowing a certain time for the consideration of the foregoing, the following questions were put :—

Question 1. What have you to arrange after receipt of your orders?

Answer. a. Preparations for the march.

b. Assuming command.

c. Orders for the advance, means of maintaining connection, and the transmission of messages.

d. Means for the security (of the main body) during the halt.

Question 2. What do you include in preparations for the march?

Answer 1. Explanation of the duties, &c., of the different parts of the detachment

2. Orders for their necessary composition.

3. Engaging guides, reconnoitring the road, and obtaining maps or sketches.

4. Arranging about rations, &c.

Question 3. What does "Assuming the command" entail?

Answer. Control of the composition of the command, of the strength and fitness of the different parts, and satisfying oneself that all preliminary orders have been fully carried out.

Question 4. What orders do you issue for the advance, &c.; all orders in full. (One hour was allowed for answering this question, which was worked out in writing.)

Answer. Orders by the Officer commanding right flank detachment.

1. The detachment will march in the following order :—

No. 1 Company .... 300 paces distance..... Battalion Staff	Vanguard, 300 paces.
½ No. 2 Company ..... 50 paces distance	Main body, 100 paces.
2 mountain guns ..... 50 paces distance ..... ½ No. 2 Company ..... Signalling party.	Reserve.

2. The covering parties will be composed as follows :—

a. Advanced guard, 1 section of No. 1 Company.[1]

[1] Each advanced guard becomes, when opposite the commanding slopes, a flank guard, breaks up into patrols, which must remain until the column has passed, and then assembles at the tail of the rear guard.

As soon as the first section has been all used up as advanced patrols, the head of the company pushes forward a second one.

b. Rear guard, ¼ section of No. 2 Company.[1]

c. Right flank guard. A patrol of 1 non-commissioned officer and 4 men (the best climbers) ascends from Freiland, the eastern slope straight on to the ridge of the Klumberg (a guide to accompany this party).

3. Connection will be maintained with the main body by means of cavalry patrols from Freiland, a signal station at the turning in the road, and a party of orderlies (1 lance-corporal, 4 men) to the west of Höllhald, where the way branches off towards the Griesler.

To the Officers and non-commissioned officers commanding parties, I shall in person impart—

A. Information as follows :—

1. *Situation.*—The brigade marches to-day at daybreak from Türnitz to Schrambach, where it will halt one hour.

The advanced guard has orders to at once occupy the Schrambach end of the defile, and cover the main body during its halt. It will advance in three columns, viz. : the main body along the high road, one column on the right slope of the valley, and one column on the left slope of the valley.

Outposts will be placed across the *debouché* on a radius of about 3,000 paces.

2. Of the enemy is known and expected. . . . . (See orders by the advanced guard commander.)

3 *Duty of the Detachment.*—The detachment which forms the right flank column has to ascend the eastern slope of the valley near Freiland, cross the ridge of the Klumberg, and take up a position 3,000 paces eastward by the Pichler.

Hostile parties must be attacked with energy and dispersed, or hindered in their advance until the arrival of reinforcements. After the halt the advanced guard will be relieved.

My own Plans.—I shall endeavour to reach the ridge of the Klumberg as soon as possible, where there is a view eastward, and remain there until the advanced guard main body has entered the defile.

When the brigade moves on, a new advanced guard will be pushed on.

5. *Distribution.*—The detachment will advance in one column ; but, for the protection of the right flank, a patrol will endeavour to make its way from Freiland straight on to the ridge of the Klumberg.

B. *Detail of Orders.*—1. Order of march as already detailed.

After Freiland the different parts of the column will advance independently.

Unnecessary lengthening of these columns to be avoided.

2. The advanced guard will be composed of the 4th Section, No. 1 Company, under Lieut. R. As far as Freiland it will march along the main road, then along the footway on the eastern slope of the valley as far as the ridge of the Klumberg ; it will take with it one of the two guides, and will keep 400 paces in advance of the column. The country adjoining the line of advance, especially eastward, is to be searched to a distance of 400 or 600 paces, if possible. Should there be points more distant, which might offer to the enemy opportunities of observing or molesting the advance, patrols must be despatched towards them to a distance of even 1,000 paces. These patrols which have been thrown out to a flank must remain until the column has passed, and then follow it.

As soon as the advanced guard to the strength of a swarm has become absorbed into the flank guard, the 3rd Section, No. 1 Company, must reinforce it, and carry on its duties in the same way.

[1] The Austrian infantry battalion numbers 952 Officers and men on the war establishment. The battalion is formed of four companies, the company of four sections, and the section of four quarter-sections or swarms.—J. W. S.

Connection is only to be considered with the main body.

In case of a collision with the enemy, he is to be attacked with energy, and the slopes especially must be searched on as broad a front as possible, in any direction where surrounding the main body is possible.

Should the ridge of the Klumberg be reached without molestation, a concealed position, facing east, must be taken up on the border of the wood.

The advanced guard will be despatched at the commencement of the march. Further on, the right flank patrol and rear guard will be detached.

The party of orderlies will be left *en route* at the place assigned to them.

C. After the covering parties have assembled, I will direct the advanced guard to move off, give over my command of the column to the next senior Officer (the Captain commanding No. 1 Company), and ride on to the front in order to obtain information.

D. Before arriving at the outposts, I let the column pass me, and satisfy myself that the proper order of march is maintained, and that the other orders are being carried out.

Question 5. What measures do you take to cover the main body during its halt at Schrambach?

Answer (verbally). The detachment takes up a position near the Pichler, where the road forks, on a spot favourable for the defence as well as for initiating an attack from, pushes forward small parties to act as picquets on all possible lines of approach, and despatches patrols to a distance of 2,000 paces in the direction of the enemy's advance (to the north on to the top of the hill as far as the Hadecker, and to the east as far as where they can see into the Wiesen Valley).

To solve Problem III, the following task was then set to the students by the instructor.

It is 4 A.M. on the *n*th; the situation as before—Major M's right flank detachment has assembled at Lehenrotte; orders for the advance have been given—a collision with the enemy does not take place, and nothing is known of him.

As Lieutenant R commanding 4th Section of No. 1 Company, write an account of what your duty consists of, and the way in which you carry it out; also the orders you issue.

Time allowed, 1½ hours.

Answer. My duty consists of:—

1. Finding out and holding the line of march from Freiland on to the ridge of the Klumberg.

To find out the way, I make use of the guide told off to me; then of the map, or of a sketch from it, or perhaps only a look at it, if indeed the detachment commander has one. I place the guide under the supervision of a reliable soldier, and choose my place at the head of the advanced patrol, so that I can lead its foremost point.

I tell off a swarm as guide and to hold to the line of march. It must throw forward (300 paces) a small party of 1 non-commissioned officer and 4 men, who for maintenance of connection and greater security, in the forest defile, should march in single file at 30 to 50 paces distance from one another.

2. Searching the country in front on both sides of the way, but especially on the upper side to 600 or 1,000 paces, and covering the flanks of the column to the same distance, for which purposes I detach on all lines of approach possible for the enemy, small patrols of from 2 to 10 men, which must remain until the tail of the column has passed, and then join the rear guard. For this duty I tell off, first the 3rd and then the 2nd swarm, and when others have arrived to take their places, the 1st and 4th swarms.

3. Collecting intelligence about the enemy. All the patrols will have to do this, from all inhabitants that can be got at, and passers by, and from any prisoners they may take.

4. Keeping up connection with the main body of the detachment. For this duty I detail the 4th swarm. It must preserve a distance of 400 paces, and establish connection by means of a chain of men in single file at 30 to 40 paces apart, and eventually give the signal for the advanced patrol to halt.

5. Sending in information. For this purpose I take with me a reliable man as orderly, from each swarm; these men together form my escort.

6. Taking measures, in case of a collision with the enemy, to guard our own main body against surprise, and to arrive at a clear and speedy estimation of the strength and design of the enemy. In case of coming upon the enemy, the patrols which have been pushed out to the front or flank must conceal themselves as much as possible and observe him, and send back information about him; eventually they will have to retire clear of the column but keeping up connection with it. The advanced patrol main body will hold fast to its line of advance, overcome or disperse smaller bodies of the enemy, compel larger ones, by making vehement demonstrations, either to retreat or stand, and by means of patrols find out the strength and intentions of the enemy. Before an overwhelming advance of the enemy, it must retire fighting, above the road where possible, on the exposed right flank of the column.

To be prepared for any emergency, I will during the march reconnoitre the country incessantly and especially observe:—

a. Where a movement to a flank, especially above the road, would lead to an eventual surrounding of the enemy.

b. Where the advance along the road can be easily hindered.

c. Which parts of the road might prove difficult in case of retreat, and therefore to be passed at the right moment, if there is no way round and above.

Résumé (of the way in which I carry out my duty):—

1. Order of March.—No. 1 swarm holds to the line of advance (Guide).

No. 3 and 2 furnish flank patrol of 2 to 10 men.

No. 4 keeps up connection with the main body.

All four orderlies accompany me. When No. 2 swarm has been used up for the covering of the flanks, I ask for reinforcements, and after their arrival, despatch first No. 1 and then No. 4. When the whole section has been so used up, I go to the rear of the main body and assemble them.

2. Measures for Security.—Flank patrols at 600–1,000 paces, stay there, let the main body pass, then join the rear guard.

3. Conduct to be observed by all.—A rapid advance; to stop all persons and send them to me. In case of coming on the enemy, remain concealed, observe, and send back speedy information; to try and make prisoners, but before overwhelming forces to retreat without precipitation clear of and above the column, keeping up connection therewith.

Should the advanced patrol or main body become engaged, the flank patrols must remain halted and watch the results keenly. If the issue is favourable they will go on as before, but if otherwise they must endeavour to remain as long as possible on the flanks. The main body of the advanced patrol eventually retires above the column.

Orders.—I assemble the non-commissioned officers and instruct them as follows:—

1. The detachment will march on the high road as far as Freiland, then up the right slope of the valley in order to occupy the heights at the further end of the defile.

2. The enemy must be near.

3. The duty of the detachment is to furnish the advanced guard and undertake the covering in flank of the column on the right slope of the valley. For this purpose it must send small patrols in succession 600 to 1,000 paces up the slope, where they must remain until the column has passed when the section assembles in rear of it.

4. We will advance, to commence with, in the following manner :—

No. 1 swarm holds the line of march, and searches the ground to 200 or 400 paces on both flanks.

No. 4 keeps up connection with the detachment.

Nos. 3 and 2 are successively despatched to cover the flanks.

Between No. 3 and No. 2 a distance of 100 paces is maintained.

I will be with No. 4.

Each swarm furnishes me with an orderly.

5. Conduct to be observed by all (see *résumé* above).

6. The countersigns will be, &c.

7. Orders for the leader of No. 1 swarm. You will march at the head 300 paces in front of the patrol, have the ground searched (where possible) up to 400 paces on either flank, and be careful to keep up connection with the section. You will have charge of the guide. Place him under the surveillance of a reliable man.

8. Orders for the leader of No. 4 swarm. You will keep up connection with the main body, be responsible that the distance from it is not materially more or less than 400 paces, and eventually give the signal to halt.

The non-commissioned officers then fall in, &c., and I give the word to march.

9. Orders for the leader of a flank patrol. I despatch the first flank patrol, after passing the bridge at Freiland, straight on to the Steinhofberg (south of the Klumberg), to cover the column against attacks from that quarter.

For this service I tell off the commander of No. 3 swarm and eight men, and give him the following instructions :—

You will ascend the heights in front in a direct line until you reach the ridge, which you will follow as far as the edge of the wood, where you will remain until the main body has passed, on your left, out of the wood.

In like manner are the other flank patrols instructed. After despatching the last patrol of my section, I await the rear of the column, where I stay until I have got it together again.

After this the instructor and students followed the route of the detachment as far as the ridge of the Klumberg, in order to control the computation of the time of marching, and to discuss the difficulties of the problem in detail.

In like manner Problems 4 to 6 were solved, whilst the party made their way along the ridge between the Traisen and Wiesen Valleys.

Part IV.

Account of the Other Days' Work.

Second Day.

Problem 1. All the questions on this problem were answered *vivâ voce*. They were three in number and had reference to the duty of Brigade X, to the several lines of approach possible for the enemy, and to the means of security with regard to them.

Problem 2 required 21 questions, all of which were answered *vivâ voce* except Question 16, which entailed the filling in on lithographed maps by the students the distribution of Brigade X in its halting place on the night of the *n*th with reference to the commander's ideas and its security. Time allowed, 15 minutes. The other questions up to Question 12 were on the considerations governing this distribution in the vicinity of the enemy ; the support to be reckoned on, and the probable time it would take to arrive, supposing the brigade to be in telegraphic communication with the army; the length of time the brigade ought to keep its ground before the arrival of reinforce-

ments; the means of frustrating the enemy's plans (the answer to this was "By manœuvring, by demonstrations, or by a decisive action"); on the advisability of manœuvring, making demonstrations, or engaging in a decisive action; the different ways of making demonstrations, and the best way of doing so; the advisability of concentrating the whole brigade where the road forks near Traisen, or to distribute it with advanced portions at Maierhöfen and Scheibmühle, the main body being near or north of Traisen; the circumstances on which depends the security of troops "*en bivouac.*"

Question 13. Supposing the outposts have been pushed out, to the east as far as the Staff-spitz, to the north as far as the Upper Steinwindleiten, and to the west as far as the Tarschberg; but supposing that an early discovery of the enemy by means of wide ranging patrols, so that his advance can be at once detected by the outposts, is not to be reckoned on with certainty, would the distribution of the forces at Maierhöfen, Scheibmühle, and Traisen ensure the necessary security?

Answer. It would, if the enemy advanced by the Gölsen or Traisen Valleys or by way of the hills between them, as the advanced parties at Maierhöfen and Scheibmühle would reinforce the outposts, and the main body could quickly throw itself on the threatened point; but should he approach by St. Veit or Eschenau, making for a point south of Lilienfeld, it would not, owing to the difficult country and the distance.

Question 14 was on the probability of the enemy's advancing on both these last lines.

Question 15. On the advisability, either of making the outposts on both exposed flanks strong enough to hold the enemy long enough, or to have another force in rear of the brigade as a reserve for both flanks.

Question 16 was of course dependent on the answers to these last questions.

The remaining questions were: Whether the brigade commander, under the circumstances, would not seek a decisive action? Whether it was not possible to defeat an overwhelming foe? Whether in case the enemy failed to deploy his forces for want of room or for want of time, it would not be well to try and hold him there? Whether it was probable that the enemy would advance by several routes against the brigade? And whether, because the enemy is always liable to make mistakes, and a decisive victory over one of his columns by the brigade would very much conduce to the security of the army on the left flank, with the distribution already discussed, such a victory might possibly be obtained?

Problem 3 was solved *vivâ voce.* Only two questions were asked.

Question 1. What should be the strength of the different groups?

The answer to this question commenced by laying down, as a general rule, that the advanced guard and reserve should be as weak as possible, provided the main body could reinforce them with as strong a force as possible at the right moment and in the right place, and strong enough to fulfil their own special duties, and ended up by making the strength of the advanced guard and reserve together $\frac{1}{2}\frac{1}{4}$ of the entire brigade in this case.

Question 2. The brigade marches into Traisen 6 battalions infantry, $\frac{3}{4}$ squadron cavalry, a heavy field battery, a mountain battery, and an engineer company: of these, $1\frac{1}{2}$ battalions, $\frac{1}{4}$ squadron, and the mountain battery are told off as outposts. Where and how is the rest of the brigade to be distributed for the night?

Problem 4. Half of the students were told to consider themselves the subaltern Officers who had received instructions in Traisen to ride on to Maierhöfen and there choose and tell off a camping ground for the advanced party to follow, viz.:—1 battalion, $\frac{1}{4}$ field battery, $\frac{1}{2}$ company engineers, and $\frac{1}{2}$ the infantry pioneer party. They were allowed two hours to get to Maierhöfen and write a report on all they did, with a description of the camping ground, accompanied by a sketch, scale $\frac{1}{2500}$.

The other half had a similar task, but with reference to another group between Au and Maierhöfen on the railway, to perform.

Problem 5 was carried out as for the group at Maierhöfen.

Problem 6. The students were divided into several parties, each of which wrote reports on the various arrangements, &c., to be made in different parts of the camp, such as telling off parts of the streams, &c., as drinking water, others for washing, ramps to be cut, approaches to be made, &c.

Third Day.

Problem 1. The instructor asked four questions, as follows (they were answered *vivâ voce*).

Question 1. From which troops are the outposts usually drawn, and in this case in particular (*i.e.*, from the advanced guard or main body, &c.)?

Question 2. What do outposts consist of, and by whom is the posting of them superintended?

Question 3. Of what must the brigadier be certain of, in his own mind, before issuing orders for the outposts?

Answer.—*a.* His own duty and plans.

b. The proper positions of the outposts consistent with them.

c. The conduct to be observed by the outposts in case the enemy advances or attacks.

Question 4. What did we settle on yesterday to be his duty and plans?

Answer. His duty: to hinder all hostile undertakings from the direction of Tulln or Krems against the left flank or against the rear of the army, by way of Wiener-Neustadt or Maria-Zell, and in order to accomplish this, to hold the further end of the Schrambach defile, if possible, until the arrival of reinforcements. His plans: to watch all approaches possible to the enemy, whether direct or indirect, and to hold himself (near Traisen) ready to at once block his way, whenever he discovered him, and eventually beat his divided forces in succession.

Problem 2. The questions up to No. 12 were answered *vivâ voce*, and were with reference to the duties of outposts generally; on the necessary measures to be taken on the advance of the enemy being discovered; on the manner of carrying them out; on calculating the time which should be gained by the resistance of the outposts; on the value of and relation to one another of the considerations which favour such resistance or otherwise, viz., the distance of the line of resistance of the outposts from the line to be covered; the strength of the outposts at the threatened point; the nature of the ground; on the questions which the brigadier must solve in order to be able fully to secure his troops from being disturbed whilst detailing a minimum number of them for outpost duty; on the lines of approach open to the enemy, and the degree in which the main body could be threatened on these various lines; on the space to be covered so as to secure the main body against surprise, and to be able to carry out the necessary measures on the advance of the enemy; the time that might be gained for the main body by throwing out wide ranging patrols who could send in speedy information; on the extreme distance to which outposts can be pushed out; and the advantages to be gained by the nature of this particular country in hindering the enemy's advance.

Question 13. What should be the strength and composition, &c., of the outposts in order (relying upon their distance from the line to be covered and upon the nature of the country) to gain the necessary time for the main body?

The answer to this question was a written report furnished by each student (time allowed, $\frac{3}{4}$ hour).

Problem 3. In answer to Question 13, Problem 2, the outposts had been told off into three sections, the right wing under Major M, consisting of

Nos. I, II, and III subsections or posts; the centre under Captain N, Nos. IV and V Posts; and the left wing under Captain P, Nos. VI and VII Posts.

No. 1 Post consisted of 1½ company, 3 mounted men, and ¼ engineer company. The whole outpost force comprised 5 companies, 23 mounted men, 4 guns, and ½ company engineers.

Colonel X commanded the whole of the outposts, and they extended from west of the Wiesen Valley on the right over the Steinwandleiten to the Eschenauer Valley on the left.

Question by the Instructor.—What instructions must be imparted to the outpost commanders, and what should be the orders for the commander of No. 1 Post?

To be answered in writing. Time allowed, ½ hour.

Problems 4 and 5 were solved by written reports, with sketches. Scale $\frac{1}{25000}$, for which four hours were allowed.

Problem 6 was solved by a *vivâ voce* discussion.

Fourth Day.

Problem 1 (solved *vivâ voce*). The instructor supplied the following information:—

1 The Southern Brigade is halted at Traisen; outposts are pushed out, also reconnoitring patrols (in the manner discussed in the second and third working days).

2. No fresh intelligence about the enemy.

3. The following telegraphic despatch was received from the Army Commander at 3 A.M. on the *n*th:—

"From Army Commander in Wiener-Neustadt to Commander of Brigade X at Traisen.

"No. Z.

op. "2.30 A.M. on the *n*th.

"Despatch concerning action and position near Traisen received (No. and date). To-morrow (the $n+1$th) the main body of brigade must remain at Traisen. A detachment to be pushed out towards St. Pölton, in order to force back the hostile forces there, and draw out those from Neulengbach. Where possible, the railway from Neulengbach and Melk towards St. Pölton, and eventually the bridge at Krems, to be destroyed.

"I purpose (on the $n+2$nd) to withdraw a large portion of the brigade from Traisen, and secure the left flank by means of entrenchments near that place.

"Commence entrenchments at once with all available men and means. They must be completed at midday on the $n+2$nd.

"Eventually ½ a mountain battery and ½ a squadron cavalry of the brigade can be employed to assist in occupying them.

"The rest of the brigade must be ready to march at daybreak on the $n+2$nd."

Problem 1 was solved by a discussion and by examples of plans of works on lithographed sketch-maps, executed by the students under the superintendence of the instructor.

Problem 2 was solved by two questions answered *vivâ voce*.

Question 1. What considerations arise in the erection of the entrenchments?

The answer pointed out four tactical requirements, viz.:—

1. Closing of the fork formed by the valleys near Traisen, and protection of the line of retreat on Maria-Zell.

2. Defensibility on all sides.

3. Power to hold out until relieved.

4. Capability of being held with as weak a force as possible.

And one technical, viz. :—

Completion of the works in 36 hours.

Question 2 demanded to know the situation of the works, with reference to No. 1 tactical requirement.

Problem 3. Three questions by the instructor (answered *vivâ voce*).

1. As to the necessary works to be constructed, and where they were to be, was answered by help of the map, and after a reconnaissance of the neighbouring country, by the students.

2. As to the strength of the occupying forces so as to be certain of holding out at least 24 hours.

(It was decided that 4 battalions, ½ squadron, ½ mountain battery could be spared from the brigade to rejoin the army.)

3. As to the carrying out of the orders for the construction of the works, &c.

Problem 4. Seven questions, all answered *vivâ voce*, on the situation after those troops, to rejoin the army, had left Traisen ; on the object of the entrenchments (recapitulation of the duties of the brigade, second day's work) ; on the support to be reckoned on by the troops occupying the entrenchments ; the time which ought to be gained by their defence ; the probable manner in which the enemy would attempt to paralyze the completion of the entrenchments ; the best way to prevent his doing so ; and, lastly, on the general plan of defence.

Problem 5. The instructor designed the different works generally, and the students made sketches adapting them to the ground, and showing their plans and profiles.

Problem 6 was solved by a *vivâ voce* discussion.

Fifth Day.

On the $n + 4$th the following despatch was received by the Brigadier from the Army Commander :—

"Do all you can to stop, or at least delay, the advance of hostile forces against the left flank of the army, to the east of the road Hainfeld-Payerbach, and observe especially the road Traisen—Maria-Zell—Bruck on the Mur ; and endeavour still to hold the line of the Gölsenbach on the $n + 5$th."

This despatch, as well as a summary of the situation, was communicated to the students by the instructor ; after which Problem 1, South Party, was solved by *vivâ voce* discussion.

The questions were—

What is the duty of the brigade, especially on the $n + 5$th ? Can it reckon on any support on that day ? Are the entrenchments near Traisen calculated to be of much assistance ? Can Brigade X, by taking advantage of the country, march out some distance and beat the enemy's two columns one after the other ? Would it be advisable that the main body of the brigade should go far out ? Which column should be first attacked ? Would it not be advisable to beat the weaker one first ? Could not the main body of the brigade, retiring before the enemy's advance by Hainfeld on Klein-Zell and Hohenberg, reach the Freiland end of the defile before him ? What is the idea for the operations on the $n + 5$th ?

Problem 2. *South Party.* Twelve questions on the probability of the enemy's having already discovered the retreat of the main part of the force, and marching boldly on Traisen ; or, on the other hand, on the possibility of keeping him deceived until nightfall, and the ways and means of accomplishing this.

Problem 3. *a.* Questions on how the freedom of action of an army corps, generally, and especially of Brigade X against the St. Pölton column, can be limited by time and space.

b. Question. What means are available to guard communications and secure retreat against a hostile attack during a certain time, and which would be the best in this case?

After this question had been answered in full detail, the students had to write reports on the choice of a position near Wilhelmsburg as the basis for a defensive-offensive decisive action of Brigade X.

1½ hours were allowed for this report, which included a description of the neighbouring country and of the position.

c. Four questions were asked: as to whether the enemy would attack the position at Göblasbruck when he knew that the main body of the brigade was concentrated there; how he could be deceived about its strength and intention; whether the advanced guard should endeavour to materially hinder the enemy's advance; and what was to be done should he decide to surround the position.

By the answers to these questions the idea for the action was worked out with the students.

d. The chief points in the plan of action were fixed on by a discussion on the foregoing.

Problem 4 (preparing for the decisive action, in which the South Brigade Commander seeks to annihilate the St. Pölton column) was discussed *vivâ voce* by the instructor and students under the following headings:—

I. Orders for the covering of the defensive works in front and on the flank.

II. Orders for the destruction of all passages over the Traisen and Pielach below the position, and afterwards for the establishment of new ones above it.

III. Employment of the half-brigade near Traisen as working parties, and requisition of labourers and working tools on the country.

IV. Scheme of the plans of entrenchments for the defence of the position at Göblasbruck.

V. Orders for and carrying out the work.

VI. Sketch of the orders for the distribution of the forces, &c.

Problem 1. *North Party.* The instructor imparted to the students the following order, transmitted by the Brigadier Commanding, on the morning of the $n+4$th to the commander of the half-brigade at Altengbach:—

"Advance in the afternoon by Laaben, reconnoitre the enemy, and seize, if possible, the passage into the Gölsen Valley, so as to have a view into it; in any case try to hold the enemy, if he is in superior numbers, until the brigade has entered the Gölsen Valley, and then follow close on him."

The instructor also told them how the Brigadier instructed him as to his further action, should the enemy be in small numbers and retreat on Klein-Zell or Traisen; and informed him of his plans for the $n+5$th.

This problem was solved *vivâ voce.* Twenty questions were asked, all on the general duty of the northern detachment, the probable position of the enemy according to the latest intelligence received, the duty of the detachment near Altengbach in particular, different ways of performing it, chances of success, chances of being supported, means of avoiding hostile forces if necessary, or manner of attacking them under various circumstances, danger of being surrounded, the roads to be used in the advance to Wilhelmsburg, the importance of them with reference to the possibility of a collision, &c.

Problem 2. The students received two lithographed plans each, one on a scale of $\frac{1}{75000}$ the other on one of $\frac{1}{7500}$.

They were called upon—

a. To draw the probable lines of advance, &c., of the brigade on the $n+5$th (with explanations in writing on the first plan).

b. On the same plan to fill in the situation of the various parts of the brigade at 6 A.M. (with explanations in writing).

c. On the other plan, to draw the columns of march in detail (without covering detachments) also with explanations in writing.

Time allowed, 2 hours.

Problem 3. Command of the ½ squadron of the right flank column,[1] during the advance of the brigade on Wilhelmsburg.

Half an hour was allowed to write an account of the action taken by its commander from his time of marching (4.30 A.M. on the *n* + 5th) until the first disposition of his forces for reconnoitring.

Problem 4. On the command of the patrols, and their supports found by this ½ squadron, reconnoitring along the lines of advance of the brigade, was solved *vivâ voce*.

Sixth Day.

Before proceeding to the solution of the problems, the instructor gave the students a summary of events (periods of the commencement of the action).

Problem 1. *South Party*. The students were allowed half an hour to write out the action of the commander of a ½ squadron of the advanced guard, after receiving his orders verbally from the advanced guard Commander.

NOTE.—This problem, on account of its similarity to Problem 4 of the Northern Party on the 5th day, was not insisted on.

Problem 1. *North Party*. It is 5.20 A.M. The brigade is on the march towards Wilhelmsburg, covered along its whole front by its cavalry. The students were told to consider themselves as the commander of the centre patrol (1 Officer, 13 men), and were addressed as follows by the instructor: "Your advanced point, which has already traversed the high road from St. Pölton to Grafendorf and ridden round west of the piece of wood which lies south of Völtendorf, discovers two hostile mounted men coming towards them from the south. They are about 2,000 paces off, and do not seem to have yet perceived the patrol. Your advanced point gives the signal 'enemy,' and remains concealed and observes."

Questions. What is the general object of your patrol? How do you act after discovering the enemy's scouts?

These questions having been answered *vivâ voce*, the instructor discussed further the circumstances connected with the impending combat, and ended up by causing the students to write out an essay, with sketch, scale $\frac{1}{75000}$, on the struggle between the two advanced cavalry parties from the moment of collision until the overthrow of the Northern Party.

Time allowed, ¼ hour.

Problem 2 *for the South Party*. The students were allowed one hour to write out the duties, &c., of the company of the advanced guard employed as covering party for guns. This report embraced the following matters:—

1. Short reconnaissance of the country.
2. Summary of orders.
3. Disposal of the company.
4. Visiting and rectifying its positions.
5. Reconnaissance in detail.

Problem 2. *Northern Party*. The students answered, *vivâ voce*, four questions, as to when the company forming the vanguard of the right flank column should commence to reconnoitre, and on the strength and duties of its advanced patrol. They then filled in on a sketch, scale $\frac{1}{75000}$, the positions

[1] This column, consisting of ½ battalion infantry, ½ squadron cavalry, 1½ batteries, &c., had been detached to clear the space between the Traisen and Pielach of hostile detachments, and cover the passage of the main body by way of Traisen, and then rejoin it.

of the company at the time its main body had reached the group of houses at Wetzersdorf.

Problem 3. *South Party.* The students were allowed one hour to write out an account of the duties of the advanced guard artillery commander until the moment of opening fire.

These duties consisted of—

1. A reconnaissance of the position to be taken up.
2. Conducting the $\frac{1}{4}$ battery to the position.
3. Observation of the enemy's advance.

Problem 3. *North Party.* Was answered *vivâ voce.* Sixteen questions were put to the students on the duties of the company under the circumstances, the danger of the enemy being in overwhelming numbers behind the approaching cavalry and artillery, the chances and means of forming an estimate of his strength, position, and intentions, on what constitutes securing the main body against surprise, the direction in which it should make demonstrations, and what should be considered in the choice of the direction, and this also with reference to its own security, &c.

Problem 4. *South Party.* A *vivâ voce* discussion was held on the objective for the guns. The advisability of impeding the enemy's reconnoitring parties, compelling his columns to deploy, combating his infantry attack, or whilst merely observing and checking his other arms, of engaging in a duel with his artillery.

Problem 5. *South Party.* Was dealt with in the same sort of way. The conduct of the company and guns if suddenly attacked on the flank by the enemy's infantry was discussed.

Problem 4. *North Party.* Fourteen questions, some of which were on the duties of the artillery at the commencement of the action, having been answered *vivâ voce* by the students, they were allowed half an hour to write out an account of the doings of the commander of the leading battery (and make a sketch showing the line of advance and position of the battery in action) until the moment of opening fire.

The remaining problems of both parties were solved *vivâ voce.*

Seventh Day.

As only half of this day was available for work, all the problems were discussed very shortly.

After this the two parties of students were united, and as a conclusion to the whole scheme, the following subjects were discussed :—

1. The reason and causes of the defeat of the Northern Brigade.
2. The possibility of an essentially different state of affairs, which might have been occasioned by the influence of the initiative assumed by some subordinate commander, by some accident, or by other circumstances.

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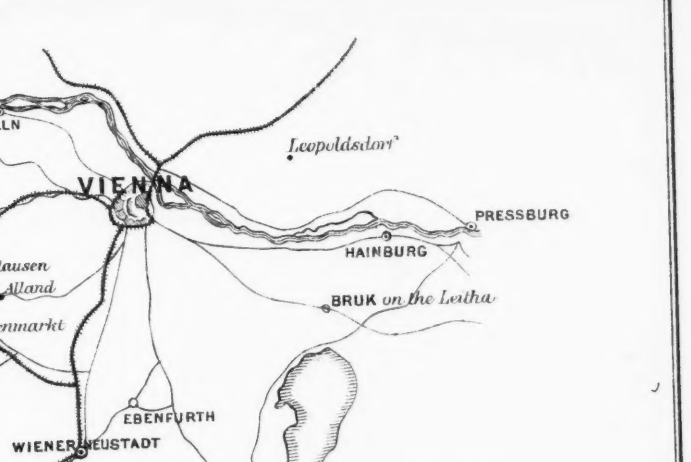

Scale of Miles

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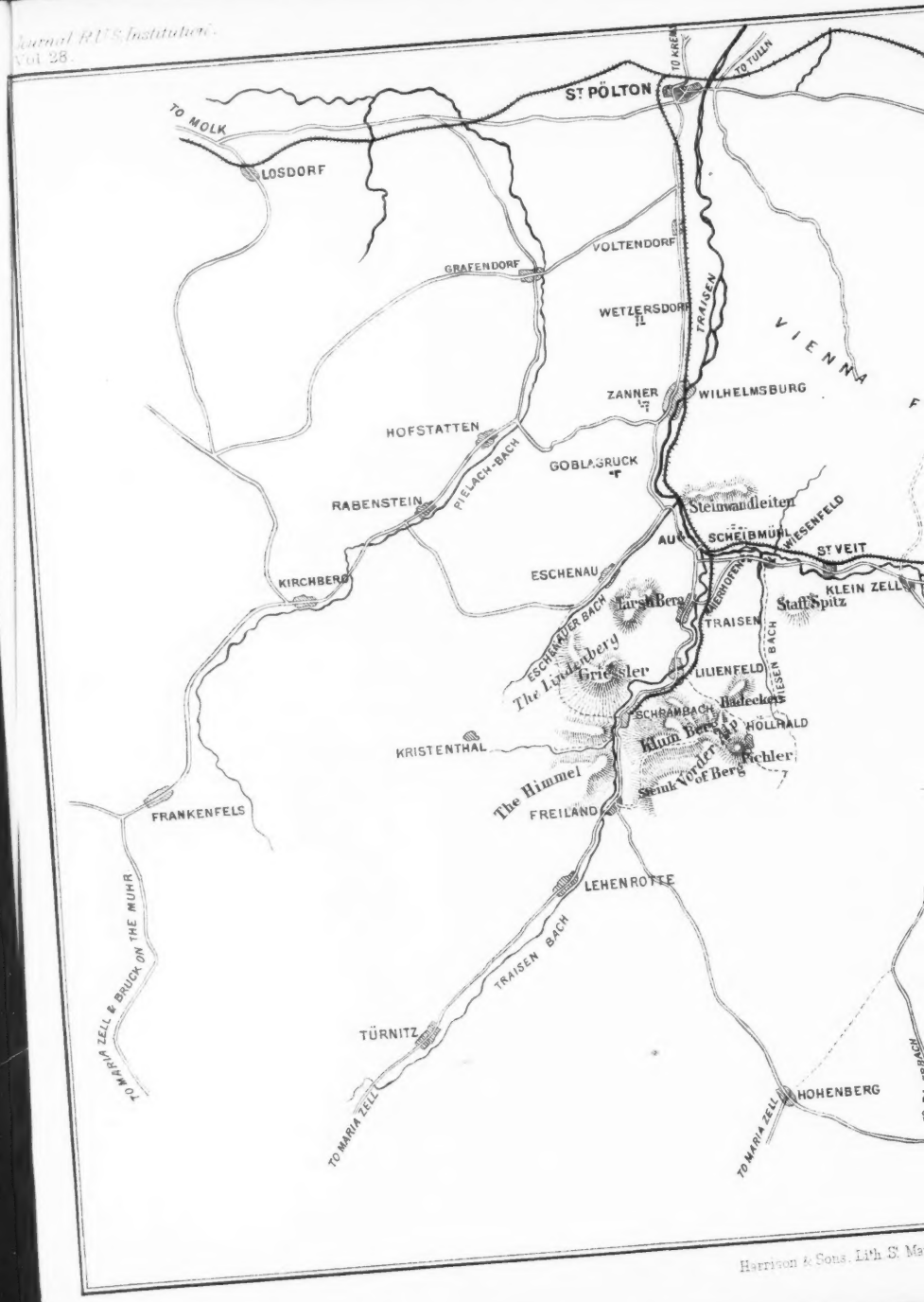

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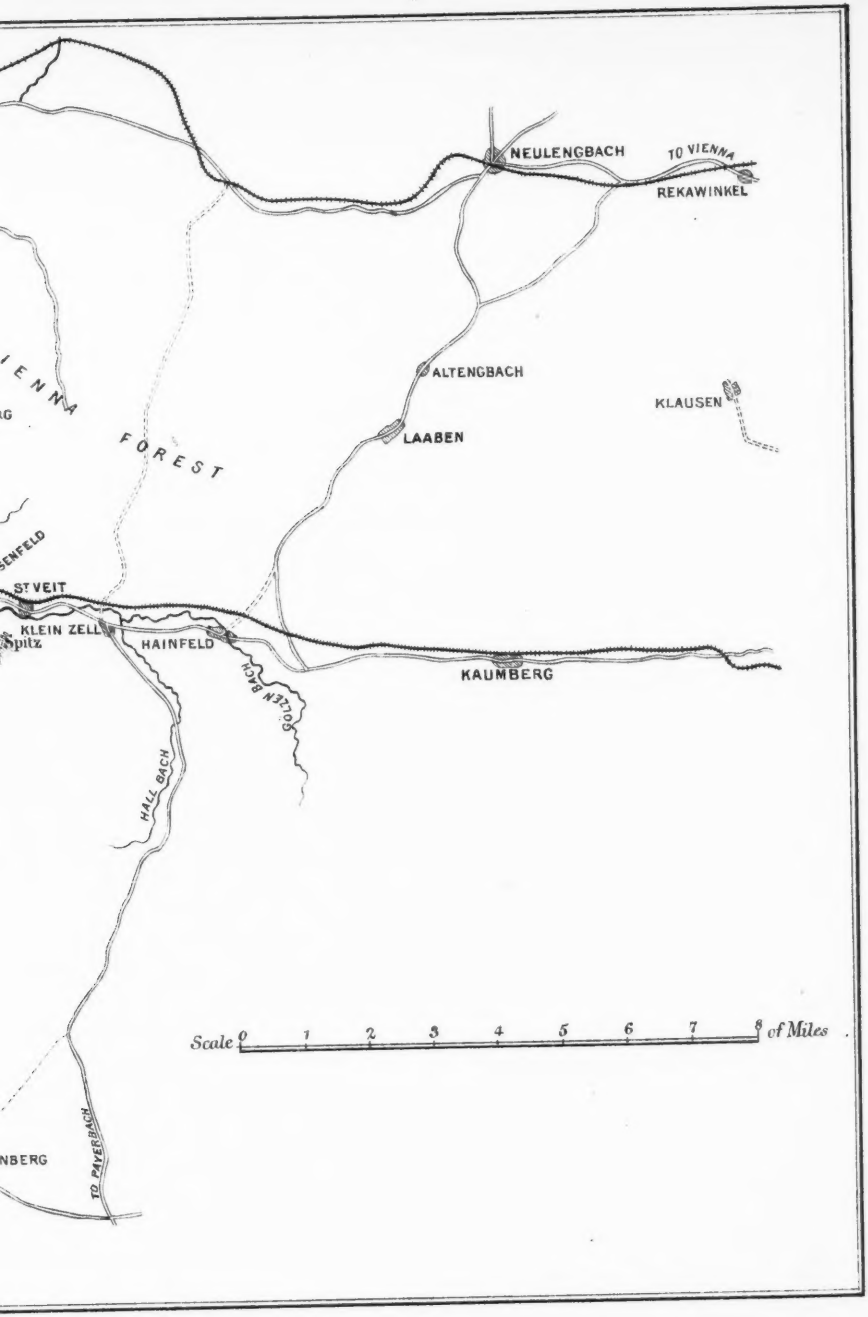

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REVIEWS.

Handbook of Artillery Matériel. By F. C. MORGAN, Captain Royal Artillery, Instructor in Gunnery, School of Gunnery. With plates. London: Clowes and Sons, Charing Cross, 1884. Pp. 108. Size $7\frac{1}{2}'' \times 5'' \times \frac{1}{2}''$. Weight under 9 ozs. Price 5*s.* 6*d.*

In a concise and handy form, this work puts before us a short description of ordnance, ammunition, carriages, machines, and stores in the service of the Artillery. The only other way to obtain the information Captain Morgan gives, would be to wade through the various official manuals and handbooks, and then to correct these by the lists of changes issued monthly; a labour which few have either opportunity, time, or inclination to undertake. Captain Morgan has met a want keenly felt.

The Tactical War Game. A Translation of General v. Verdy du Vernois' "Beitrag zum Kriegsspiel." By J. R. MACDONNELL, late Major R.V. London: Clowes, Charing Cross, 1882. Pp. 114. Size $6\frac{1}{4}'' \times 4\frac{1}{4}'' \times \frac{1}{2}''$. Weight under 8 ozs. Price 3*s.* 6*d.*

Although almost simultaneously with the publication of Major MacDonnell's translation, "Revised Regulations for the Conduct of the War Game" have been issued officially, the value of this little work has been enhanced rather than diminished thereby; for whilst the regulations lay down rules and principles in the abstract, the translation gives an example of the right way of applying them. General du Vernois is one of the most accomplished soldiers of Germany, and his approval of the game of Kriegsspiel is in itself a sufficient answer to those who from ignorance or superficial knowledge of the exercise regard it of little practical value. In the preface the General says: "I have resolved . . . . to make the attempt (to explain the game) in the hope of being able to help towards a more extended acquaintance with the exercise in question, which is at once so exceptionally useful for the education of every Officer, and is at the same time so interesting. I write especially for those of my brother Officers who, it may be, have been hitherto frightened away by the Dice and Tables of Laws and Rules." The General fully admits the difficulty of satisfactorily performing the duties which the umpire has to undertake, and it is probably this difficulty which has prevented the exercise making its way in the British Army as it ought to have done. Of course an Officer who knows nothing of the working of the three arms, or who will not study the rules, or who is too diffident of his own professional knowledge to give a decision without endless references to the Book of Rules, is hopelessly incompetent to conduct a war game; but a confession of any one of these weaknesses is tantamount to one of want of professional knowledge and of unwillingness to take trouble to help his younger brother Officers in a most important branch of military study. It must be assumed that every Field Officer knows something of the working of the three arms, and that he has sufficient strength of character to not be unduly sensitive to the criticism of those of a rank lower than that which he himself holds. Such a man will with a little practice make a very fair umpire, and we would recommend him in answer to any cavils at his decisions to make the reply once uttered in our hearing by a General Officer who was umpiring a game: "My dear Colonel, you object to this decision, you say it is a wrong one; I am willing to admit it, but it is not the first I have given and assuredly it will not be the last." General du Vernois' work is, we may add in conclusion, an excellent example of Minor Tactics.

Cavalry in Modern War. By Colonel F. CHENEVIX-TRENCH, Military Attaché at St. Petersburg. London: Kegan Paul, Trench, and Co., Paternoster Square, 1884. Pp. 288. Size $6\frac{3}{4}'' \times 4\frac{1}{2}'' \times \frac{3}{4}''$. Weight under 14 ozs. Price 6*s.*

This book is one of the valuable series of military handbooks edited by Colonel C. B. Brackenbury. It is not a text-book for examination purposes, but a manual in which will be found cavalry work treated from a broad point of view, whilst at the same time there is no lack of information with regard to the details of the working of this arm. It is the best work on cavalry which has appeared for a long time. The incisive remarks contained in Colonel Brackenbury's preface we commend to all cavalry Officers, and especially to those fond parents and guardians who think that because their darling Tom, Dick, or Harry is good across country, that therefore he possesses all the qualifications for a cavalry Officer.